N.A.C.A. BULLETIN

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N.A.C.A. BULLETIN

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The Accountant's Business With Business Forecasting

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Identifying the planning function as one partly neglected and yet containing essential elements of the decision-making process, the present author discerns in the function of the accountant a relationship to internal planning through internal forecasting which broadens out to a challenge to accept the responsibility for external forecasting, except in the minority of companies professionally staffed for it.

THE PLANNING FUNCTION has, historically, received the minor share of attention in business. Probably this stems from two reasons: a lack of suitable technique for formalizing planning and of usable data which could be employed. Whether these or other reasons account for it, the fact remains that planning is the weakest of the management functions. It seems to me that a good portion of the difficulty in planning has arisen from a misconception of the term. Too frequently, planning is considered a single process. This is no more correct than to consider golf as one skill. The golfer knows that the game is broken up into particular shots, strokes, and approaches, the total of which is the game of golf.

Decision-Making Involves Forecasting

This analogy holds true for planning. More correctly, it is the decision-making process and consists of a number of individual processes which include:

1. Research into and observation of factual data, i.e. examination of records, reports etc., in quantitative terms.
2. Research into and observation of qualitative factors, i.e., determination of influences such as weather, politics, etc.

3. An analysis of these data and factors, i.e., breaking them up into those items which affect the business or the particular problem.
4. An evaluation of these data and factors, i.e., determination of their effect on the business or the particular problem.
5. The determination of several alternative courses of action based on the foregoing determination.
6. The evaluation of the advantages and disadvantages of these alternative courses of action.
7. The selection of the best course of action to follow.
8. The determination of the timing and procedure to be employed in following this course of action.

This, then, is the planning or decision-making process. It has been neglected because it is difficult to follow and is contrary to developed habits. We have done a certain thing under a certain set of conditions and results were satisfactory. Therefore, we will do the same thing when similar conditions arise. The only thing wrong with this line of reasoning is that we too often look back and see that we did not attain desired results because what we thought were minor factors proved to be the major ones.

It can be agreed that decision-making for the general policies and operations of a business are the prime responsibility of the executives of the business, the president, vice presidents, general manager, or whatever the titles may be. At the same time, today's businesses are so complex and the business world, itself, is so complex that no executive can discharge the planning responsibility alone. Each man responsible for a specific function—the head of accounting, the personnel manager, the purchasing agent, the sales manager, etc.—must participate in the decision-making process. Here our particular concern is with the accountant. What is his responsibility in the decision-making process?

The decision-making process involves action which must be taken in the future. The fourth step in the decision-making process, given above, is the evaluation of factual data and qualitative factors and the determination of their effect on the business or the particular problem. This is business forecasting. A forecast is a prediction or estimate of any future event or situation. And there is no escape from the forecasting responsibility. It is not a question of whether your company makes business forecasts but of how it makes them. As soon as the words "tomorrow," "next week," "next month," "next quarter," "next year," are used, the remainder of the sentence is a forecast. Generally, we can say that a forecast cannot be either entirely mathematical or entirely qualitative. It must be a blend of good mathematics and good common sense. Also, it can be said that the degree of accuracy sought in forecasting varies with different companies and industries.

From Internal to External Forecasting

But how does the accountant fit into this picture? Traditionally he has supplied about one-half of the raw and processed data employed in forecasting. The accountant supplies the data for the internal forecast covering the operations and factors which can be controlled within the framework of the company organization. His responsibility deals, or should deal, with the following:

1. Forecast or budget of annual sales.
2. The establishment of a profit objective.
3. The establishment of a factory and headquarters expense budget consistent with the profit objective.
4. Forecast of product standard costs and variances at budget volume.
5. Forecast of operating profit or loss before taxes.
6. Forecast of taxable income, State and Federal income taxes, and net income.
7. Establishment of capital investment programs and appropriation schedules.
8. Forecast of cash resources.
9. Forecast of cash requirements.
10. Forecast of new capital requirements.
11. Forecast of changes in assets and liabilities.

These responsibilities constitute the first of the accountant's roles in business forecasting. These items have a relationship to the entirety of forecasting which is often overlooked. Unless these individual forecasts are prepared, how can a company plan? The tendency to make organized labor a fixed cost; the increased cost of hiring and maintaining a labor force as a result of guaranteed annual wages, seniority, transferable pension rights and severance pay; and the problems of stabilizing employment require careful planning. In addition, the systematic projection of inventory needs and cost-price relationships is essential to maintaining a favorable competitive position. Fortunately much has been done to improve internal forecasting. New techniques have resulted in improved methods of solving problems concerned with decision-making. Linear programming, a mathematical technique, is only one. It can be employed to analyze problems of optimum inventories, production schedules, sales efforts, pricing policies, business expansion, direction of research, evaluation of alternative projects and external economic factors, although, as a mathematical technique, it cannot handle qualitative aspects of these problems, unless the qualitative aspects can be expressed in quantitative terms or imputed through relationships.

But the accountant's responsibility does not stop there. It extends to the field of external forecasting and hence to Parts 2, 3, and 4 of the decision-making process, enumerated on a previous page. Any forecast which will be of value in this process must include both the internal forecasts and an external forecast. It is this external forecast which is the disturbing element, so to speak. This is the forecast of conditions beyond the control of the individual company but which have an influence on its situation. Nor is such a

forecast a secondary matter, even though we have reached it here by way of the accountant's primary responsibilities, for an external forecast should be made before the internal forecast is prepared. The latter will rely to some degree upon the external forecast, depending upon the scale of operations and the area from which purchases are made and that in which sales are made. Thus, the external forecast of a grocery serving a neighborhood of one square mile is easier to make than that of a food processor serving several states or the entire country, while the equipment manufacturer who sells in the United States and Latin American countries has many more external influences to consider.

Progress of Forecasting From Bad to Better

This matter of external forecasting has been the biggest obstacle to effective business planning. All of the business functions, all of the management functions, and each step in the decision-making process can be studied in the light of internal, controllable, experience. But it takes a very capable (or else a completely unintelligent) man to make positive external forecasts. There are two aspects of external forecasting, industry or market-group forecasting and national forecasting.

In the case of industry or market-group forecasting, a considerable body of technique has been built up, although most of this has been on a trial-and-error basis. Trade associations and business associations have collected data, sampled intentions and presented forecasts, based generally on projections of total output, the volume of trade, new orders, inventories, construction, payrolls, etc. These are useful if the forecaster has knowledge of the company's projected relative position in the industry. But they are not particularly useful for local markets where competitive positions change and where, in fact, the business may be interested in improving its competitive position. Too frequently, these association forecasts are simple mathematical trend calculations which may be misleading for the individual firms. For example, such a projection of the farm population might indicate that there will be no farmers in Louisiana by 1970, a highly questionable conclusion.

What should be the accountant's role in this most neglected of the most neglected fields, the job of determining the external forecast for a particular company. It is, I believe, the new field in which the accountant should seek and accept responsibility, for he is in a strategic position to prepare a forecast without the optimistic bias of the sales manager or the conservative bias of the production manager. Also, he has the necessary mathematical skills, de-

veloped by his experience in internal forecasting. (He has certain handicaps, too, which I will reserve for discussion in a later paragraph.)

What are the objectives of an external forecast of general business conditions, national output or product, national income, indices of production, price indices, etc.? There are these objectives in the individual business: to help shape overall policies, and to establish a company forecast as a percentage or proportion of the national or regional market. They are highly important objectives. Yet, when we get into this field, we are sailing relatively uncharted waters. Although there was some business forecasting prior to 1930, the depression demonstrated clearly the inadequacy of the then accepted techniques.

Serious consideration was given after 1930 to developing new techniques. It is only since 1930 that private economists have been generally employed to give serious weight to external factors in making company forecasts. Early forecasting was disappointing. First of all, there were inadequate data. Governmental agencies had collected mountains of facts and figures but these had not been placed in categories useful for forecasting. Then, too, forecasting in a depression was a rather discouraging experience, for too frequently business decision-making was aimed at the salvaging of the business. As a result, retrenchment was often directed beyond the necessary point. Business managers were not looking for optimum points of operation but minimum points.

Also, the tools for forecasting were not available at that time. A knowledge of economic principles and analysis is essential to sound external forecasting, but economists were in much dispute over the dependent and independent variables which constituted and affected economic life, and the joining of economics and mathematics had not yet fully materialized. Moreover, the mechanical and electrical devices were not adequate. The slide rule, the adding machine, and the desk calculator were not suitable for digesting the masses of data which must be processed in national forecasting. Also, high speed computers were just beginning to attain acceptance.

But the late thirties and the war years saw changes. Greater stability had come to economics. (The economists still disagreed, but they were more precise in their disagreements.) The collection of data had improved. More data, more carefully selected were available. And the expanding market, an institution of our times, made forecasting easier. At least the direction was usually clear. However, the relationship between spending and the level of business activity, the status of investment spending, the problems of excessive saving, the relationship of monetary factors to business activity and the price level, the relationship between employment, income and money were all felt to be a matter of hypothesis.

Signs Which Point to Forecasting as the Accountant's Job

This brings up the question of where are we now. We have stated that the accountant is doing a good and constantly improving job of internal forecasting. We have stated that business must make external as well as internal forecasts. We have stated that the accountant should be responsible for external as well as internal forecasts. But we have also stated that no one, including all of the high-powered economists, is doing an excellent job of external forecasting. So why saddle the accountant with this new responsibility? The answer seems clear to me. These are the facts:

1. We must make external forecasts.
2. The accountant is in the best position to evaluate company progress.
3. The accountant has experience in internal forecasting.
4. The accountant has mathematical skills and aptitudes.
5. There are not enough economists in the country to staff every business.
6. The assignment does not logically fit any position description other than that of the accountant.
7. The accountant has sufficient intelligence to study economics in his spare time and acquire a working knowledge of economic factors in business life.
8. The science (or art) of business forecasting is improving so that there are principles and rules of the road to guide the new practitioner in this field.
9. Accounting equipment manufacturers will devote an increasing portion of their time to forecasting applications.
10. Forecasting may be done on a group basis, either through community efforts or through joint efforts by related businesses.

In summary, systematic, organized forecasting and planning is necessary to sound management and will be a widely recognized function in the very near future. Forecasting and planning are at long last receiving the attention they deserve. The accountant will have an increasing responsibility for external forecasting, since he has the intellectual tools for this and since no one else is particularly anxious to accept this responsibility. My recommendations are:

1. The accountant should re-examine his responsibilities for internal forecasting for his company.
2. He should evaluate the techniques used by his firm in making internal forecasts.
3. He should study formal forecasting procedures and techniques to be sure that his firm is doing the best possible job.
4. He should direct his attention to the extent to which external forecasts are prepared, and should be prepared, for his company.
5. He should begin a study of, or refresh his knowledge of, the broad economic factors which affect business operations.
6. He should exchange his experiences and opinions with other local forecasters.

In short, the accountant should accept and seek the responsibility for both internal and external forecasting for his firm. By doing this, the accountant will broaden the scope of his responsibility and complete the natural implications of his function on the management team.

Planning the Future of a Successful Product

by J. CURRAN FREEMAN

Controller, Dresser Industries, Inc., Dallas, Texas

This article tells the story of the planning of expansion related to a particular product and builds logically from the level of manufactured parts through the final product. It covers the planning of sales revenue, costs, profits, and return on investment and involves facilities and working capital planning.

THERE IS SUFFICIENT evidence to convince even the most conservative of us that we stand on the threshold of a "golden age" in the economic and industrial life of America. We shall participate in the fruits of this great national growth directly in proportion to the thoroughness with which our planning is done. We need to undertake intelligent planning, based on supported facts extrapolated on the basis of careful projections and flexibly designed for quick modification as circumstances become more proximately known and evaluated. One of my associates sagely advises that, in long-range planning, it is probably still wise to ignore the dips and "look across the valley" to the next ascent, for, certainly, the long-range growth potential of the economy is as bright now as it has ever been.

This paper will not treat financial planning from the viewpoint of current interest in the subject of raising new capital to meet the needs of the greatest capital expansion in history. Provision of capital is, or may be, periodic. Hence discussion of its effective use, after it has been provided should, in my opinion, be of greater interest. This article affords us the opportunity to

1. Review a product (not an end-product) projection study just completed for one of our companies, commencing with the market analysis and culminating in a profit and loss projection.
2. Explain briefly our approach, on a project basis, to manufacturing and engineering problems associated directly or indirectly with the expansion.
3. Accord proper recognition to organization structure.
4. Highlight our control accounting techniques.

The study described was essentially the work of a team. The staff director of marketing was responsible for directing the work and for final consolidation and drafting of the study. He was aided by line management, executive as well as sales, finance, manufacturing and engineering.

Projecting Product Sales Volume Over a 3-Year Period

The history of the product has been one basically of the inability of manufacturing facilities to keep pace with sales potential. Consequently, it was neces-

PRODUCT XYZ MARKET STUDY - EQUIPMENT INDUSTRY SALES

Basic Market Classification	Number Units Produced in 19	Negative Application Existing or New Products OEM*	INSTAL.	Possible Application Existing Products OEM*	INSTAL.	Possible Application New Products OEM*	INSTAL.
A		X	X			X	X
B				X	X		
C				X	X		
D	3,162,000			X	X		
E	20,000			X			X
F						X	X
G		X	X				
H	128,000			X	X		
I	9,000	X			X		
J				X	X		
K	190,000			X	X		
L	300,000	X			X		
M	23,285		X	X			
N	2,000,000		X	X			
O		X	X				
P	753,000			X	X	X	X
Q		X	X				
R		X	X				

* Original Equipment Market

EXHIBIT 1

sary to do a market research study to find that potential. The product has an application in many markets. Hence each market in which the product has potential application was analysed in terms of units produced in 1955. These end products were then identified as to whether they might (possible applications) or would not (negative applications) provide a market for the product under review. (Exhibit 1) The number of end products extended by the units of our product developed its potential in terms of units and dollars for the period under projection, 1957 through 1960, as shown in Exhibit 2 which also carries figures for Dresser historical sales and percentage participation in the potential market. Projections were extended to possibilities of further mar-

COMPARISON OF TOTAL POTENTIAL MARKET AND DRESSER SALES FORECAST - EXISTING PRODUCTS

BASIC MARKET	1957* Total Potential	Dresser Sales	% of Total Potential	1960* Total Potential	Dresser Sales	% of Total Potential
A						
1	$ 796,000	$251,763	32.2%	$ 862,000	$ 427,262	50.5%
2	613,650	122,730	20.0	613,650	490,920	80.0
3	344,617	28,416	8.2	113,693	113,693	100.0
4	3,299,000	790,299	24.0	3,299,000	1,649,467	50.0

* Columns for 1958 and 1959 Omitted

EXHIBIT 2

ket penetration based on price, quality and sales coverage. Through field study and customer contact, potential was verified by a study of competition, whether direct, competitive or comparable method. It can be appreciated that findings of the field study have multiple value in research and product engineering as well as manufacturing techniques and costs. To finalize the program in terms of production, it was also necessary to make a detailed study of distribution methods and techniques, not previously required in a market the potential of which so outstripped production capacity. Anticipating the results of this study in terms of forecast sales, for purposes of perspective let us say at this point that the study projects a multi-million dollar increase in sales of 300 per cent in 1960 over 1955.

Following Through to Manufacturing Implications

Thus far we have reviewed the market potential and product forecast approach, the latter in terms of unit and dollars. Looking to production problems, the study proceeded from this point to project units and dollars in terms of styles and sizes, total potential as well as estimated Dresser participation. This detail is neither academic nor sophisticated, if the practical problems of manufacturing conversion (men, methods and machines) are kept in mind. It provided the starting point for manufacturing projection. The analysis of the manufacturing aspect of this expansion covered

1. Equipment requirements and production capacity 1955-1960 (Equipment investment).
2. Equipment (selection and automation).
3. Manpower requirements.
4. Plant layout and plant location.
5. Manufacturing expense.
6. Cost reduction.
   a. Material cost.
   b. Labor cost.
7. Detailed manufacturing problems to be resolved.

Following the bill of materials "explosion" techniques, units of the product were reduced to parts requirements in terms of present equipment capacity and projected requirements for machine capacity during each of the years under study through 1960. As shown in Exhibits 3 and 4, capacity requirements were developed by parts total, machine, and capital expenditure in amount and cash date. Summarized in terms of individual machines and dollars, a proposed equipment investment of over $2,000,000 became evident. The equipment selected for immediate procurement is the net result of a complete evaluation of a two-year study and continuing conference with machinery builders, including automation studies. Based upon the production requirements as indicated through 1960, and the inventory of equipment required to effect this production, a man-power study was completed in the detail of machines, shifts

PRODUCT XYZ, PLANT CAPACITY & EQUIPMENT REQUIREMENTS
(Columns for 1957 and 1959 omitted)

Order Date		1956	1958	1960
	Part A (Prod. Required)		11,800,000	17,400,000
	1956 Present Equip. Capac.	3,960,000	3,480,000	3,000,000
*1956	*(1) New Equip. Type		1,600,000	1,600,000
1956	(1) " " "		1,600,000	1,600,000
1957	(2) " " "		3,200,000	3,200,000
1958	(3) " " "		9,880,000	4,800,000
1959	(2) " " "			3,200,000
				17,400,000
	Part B (Prod. Required)		11,800,000	17,400,000
	Present Equip. Capac.	8,800,000	8,800,000	8,800,000
	(1) New Equipment		8,800,000	8,800,000
			17,600,000	17,600,000
			1,670,000	2,504,000
	Assembled Product (prod.)	* on order		
	Present Equip. (Capac. O.)			

EXHIBIT 3

and hands required. Understandably, expanding a business 300% in five years also required a plant layout study. This study included plant location and activity relocation covering the usual items of freight rates, labor availability and labor rates, detail layout of manufacturing and service facilities, and total expenditure required. Completing the preparation of raw data, a detailed yearly manufacturing expense projection was prepared through 1960.

PLANT CASH REQUIREMENTS FOR EQUIPMENT

Product *XYZ*

TOTAL	1960	1959	1958	1957	1956	CASH DATE
					80,000	1956
				80,000		1957
			160,000			1958
		240,000				1959
	160,000					1960
720,000						
			13,000			1958
13,000						
				73,000		1957
			73,000			1958
		73,000				1959
	146,000					1960
365,000						
				60,000		1957
			60,000			1958
		60,000				1959
180,000						
				54,000		1957
			54,000			
108,000						

EXHIBIT 4

The Projection in Statements and Charts

Having the above data in hand we were able to complete a projected profit and loss statement in the customary manner. The treatment of wage differentials (on a physical relocated plant basis) and manufacturing cost savings deserves a word of comment. Labor rate differentials, particularly on a union-non union basis, were not allowed as a cost saving claim. Time can conceivably wipe out the differential and we believe that long-range decisions to invest should be supported by long-range considerations. Though there may be good and sound arguments for estimating manufacturing cost savings, we accepted the program strictly on a straight dollar profit increase, producing the same percentage to sales as presently generated. These statements apply to the long-range. For the fiscal period immediately ahead cost savings claimed are critically reviewed and evaluated cost and profit-wise.

To complete the financial projection, estimated balance sheets through 1960 were prepared to develop working capital requirements and the base for the return on investment calculation. It is interesting to note from Exhibit 5 on which relevant data is graphically presented that return on investment declines rather sharply to 1959 and begins the upturn at that time. Long-range planning has many advantages. Projected far enough, the return on investment sometimes becomes a deeciding factor to invest where short-range planning or rule-of-thumb fast payouts might cause an overly conservative management to forego a profitable opportunity.

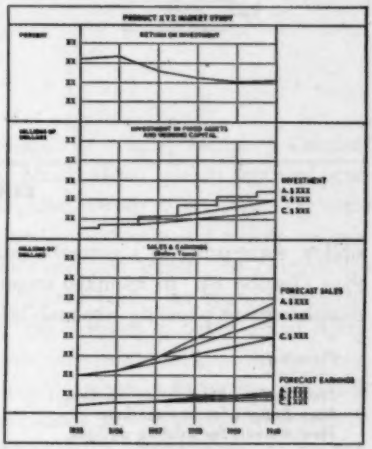

EXHIBIT 5

Organizing For Expansion of Product's Sale and Manufacture

Facilities, whether land, building, or equipment, are at best inanimate tools which require management activation to produce effectively and at a profit. It is a truism to say that what is every one's responsibility is, in the last analysis, no one's responsibility. We believe in clear cut delegation of authorities and responsibilities. In the instance of this expansion, substantial as it will be, the exigencies of the business require progressive decentralization of profit respon-

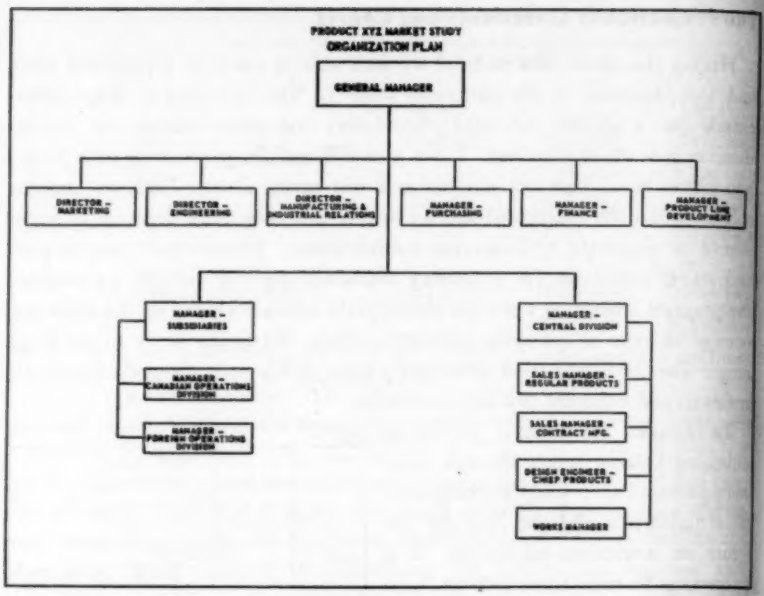

EXHIBIT 6

sibility, eventuating in a general managership as indicated in the Organization Plan (Exhibit 6). In its initial stages we contemplate a product manager with complete profit planning responsibilities on a profit center basis, encompassing:

Planning

New designs for existing markets.
New designs for new markets.
New markets for existing designs.

Putting Plans Into Effect

In all areas of
Marketing.
Product research.
Manufacturing—Tools, inventories, Etc.
Purchasing—Sources of supply.
Cost reduction.

Review and Control

Responsibility for results (Profits)

Keeping Control Over Operations

We have now reviewed product planning, set the plan of operation, and arrived at the point at which there is necessity for a system of review of actual results against plan as a basis for remedial action, where necessary, to control according to plan. In my experience, I have found the relationship of operating

profit to gross assets to be the best measure of operating efficiency. Operating profit is the result of sales revenue less manufacturing costs and operating expenses (sales, engineering, administrative and general expenses). To be sure, there are other bases to which to relate this figure, such as net invested capital or net assets. However, gross assets as a ratio denominator measures a business on the basis of continuance instead of wasting of assets. We consider the use of fixed and variable cost and expense elements as well as the direct costing of product (adding a complement of fixed expense for inventory valuation, however), as being the most effective means of developing "responsibility costs" whether at a profit center or cost center level of management. Finally, where control of cost cannot be readily measured in terms of dollars and cents, such as broad investigative and research programs in manufacturing, engineering and sales, a project control is used. In project control we set the objective, the calculated methods of resolution, the time-phasing, and progress reporting routine.

A "New Dimension" in Industry

Long-range planning as a "new dimension" in industry (Ralph J. Cordiner before the Economic Club of New York, March 1956), means depth of penetration in terms of investigation and perception. Depth of perception can come only from intensive planning born of critical, painstaking and minute analysis. This is the route we have taken in Dresser and have importantly changed the character of the company's operations in recent years. As recently as 1949, approximately 90 per cent of its sales volume consisted of heavy capital equipment having a long service life. As a result, sales and earning of the company, as then constituted, tended to exhibit the fairly substantial fluctuations typical of the capital goods industry. Subsequent acquisitions, as well as internal growth of the Dresser Companies, have been directed primarily toward increasing the portion of the total sales represented by expendable products and technical services. This planning has paid off handsomely. In the current year expendables will account for 60 per cent of our sales. While accomplishing this basic change, we have advanced detail profit planning from one year planning (fiscal year) to five years and now to ten.

That a long-range plan, even a five-year plan, may be subject to change causes no concern. Operating in a dynamic economy, we expect that to happen and, consequently, have, as management, designed all our plans, whether for material, men, money, or methods to allow us to quickly adjust to new found circumstances.

Closer Planning Through Forecasting Techniques

by GEORGE W. CHANE

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Although it is pointed out in this article that there are several known methods for predicting company sales and that prediction is made for varying periods, the prime concern of the author is that sales forecasts shall be soundly developed along statistical lines and relied on as a principal means to hold the various phases of compnay planning and operation—particularly those related to inventory—in line with each other. Methods for developing forecasts from several approaches and for cross-checking results are described.

A CORNERSTONE for successful management in most manufacturing companies is an integrated system of management planning which provides the executives of the company with answers to the following three questions:

1. For a given volume of sales, what are the optimum inventory levels which result in a competitive quality of service to customers at a minimum cost to our company?
2. Knowing optimum inventory levels for our products for a given sales volume, how can we forecast sales for the next planning period?
3. Knowing optimum inventory levels and forecasted sales, how can we budget production at a stable level and yet monitor and adjust it to maintain our inventories at optimum levels in relation to actual sales?

In this article, we are primarily concerned with the forecasting of company sales, but it should be realized that the sales forecast, the production budget, and the inventory budget are all links in the chain of successful management. No one of the three should be considered independently of the others.

Sales forecasts reflect facts modified by judgment. There are many who advocate "more facts and less judgment." It is possible to narrow the area of judgment but not to eliminate it entirely. In fact, it would be dangerous not to acknowledge the necessity for the judgment factor, since all forecasting is getting to be more complex and since no known method is infallible or uniformly accurate. The sales forecast is a key instrument in the overall planning of a company. If properly executed, it can bring about profitable operation of a business.

It is extremely difficult to be specific on a subject as broad as sales forecasting. There are no two companies with the same problems and sales forecasting must be tailored to the type of organization, the people involved, the product, and the customers. Its basic objectives can be divided into four groups, namely:

1. Sales forecasts are used to straighten out the hills and valleys in the production schedule. As a result of a more even distribution of production requirements, the purchasing department will benefit by being able to buy in balanced quantities and to get, in many cases, the benefit of price break points. In addition, more stable shop operations will be possible.
2. Proper sales forecasting opens the doors to an improved control of inventories. Consequently, these inventories can be smaller and better balanced. Moreover, better control of inventories becomes possible not only at the factory level but also at levels of distribution.
3. Proper sales forecasting makes possible improved production and inventory controls. Therefore, lower costs can be realized and inventory investments can be kept to a minimum.
4. Sales forecasting can be effectively used as a management aid when it is translated into operating controls, balance sheets, and profit and loss statements.

Constructing the Usual Sales Forecast: Field to Office

The responsibility for sales forecasting should be with the sales department. Nevertheless, forecasting will remain a compromise between the wishes of the factory for long and stable production runs and the flexibility of product availability required by the sales department. In its ideal form, forecasting should start with the customer. This is not always possible, particularly when the number of consumers is very large. In such instances, forecasting of consumer goods should start at the next level of distribution which is the dealer. The company's salesman should know the territory sufficiently well to sit down with the dealers and develop forecasts. (Incidentally, this is a valuable service to the dealer.) The salesman should combine the forecasts for his territory. The territory forecasts, in turn, must be combined by districts or regions and sent to the home office. The home office will then master-mind the collation of field forecasts into a complete package. This package should not be sent to the factory, but should be discussed with the factory before production planning proceeds. This last step is quite important since it provides for an interchange of information concerning sales and production difficulties. It should be mentioned that salesmen sometimes are optimistic in forecasting and pessimistic in making commitments. Consequently, so-called "task-setting contracts" have been used successfully to overcome this difficulty. The request to any level of distribution for sales forecasts should carry the implication that a serious and realistic reply is required.

For industrial sales, the problem is somewhat different. Here an attempt should be made to convince customers to accept sales on a scheduled contract basis. If, on a certain product, a company places a contract order for 100,000 units to be shipped over a period of from six to twelve months, the manufacturer can schedule production much better than when he receives orders in

quantities of five to fifteen thousand per month. Both the selling and buying organizations can gain from this arrangement.

Adjusting Production and Inventory Levels to the Facts

However systematically such sales forecasting is done, we must be able to apply it to the control of production and inventories. Most companies experience low inventory turnover and a back-order condition on many of the fast moving items. During the years, very little improvement has taken place towards a correction of this condition. What is needed is an improvement in our techniques of sales forecasting and a feedback of usage data into our planning activities. One difficulty, of course, is obtaining a uniformly accurate forecast. Usually, it reflects only broad product classifications. It is within the classifications themselves that trouble occurs. Standard management techniques fall short of the objectives because they are not sensitive enough to the current, ever-changing conditions, with the result that the company is long on the slow-moving items and short on the fast-moving ones. This condition is not only serious from the company sales standpoint, but it has far-reaching effects on production control and factory operations also.

Last year, our firm conducted a Demand Prediction Study for the United States Navy, with the objectives of devising more adequate and accurate means to determine what general stores items and how many of each should be kept in base supply to service the fleet. A sample of the hundreds of thousands of items were selected at random for study. The history of the issues and purchases of these items were analyzed over a number of years. The result of the study was a new method for demand prediction, based upon the mathematics of probability, quite similar to methods used in statistical quality control. Consideration is given not only to the total amount of issues but also to the quantity of each issue, frequency of issue, and the time interval between the issues, i.e., usage forecasting which, in manufacturing lines might be closely tied to improved forecast of sales. It was proposed that this information be fed constantly into a computer and memory device and that each transaction be exposed to rather complicated mathematical computations. In addition to order-point control, eight other statistical controls were applied. If the transaction placed the stock level at a point which fell within certain stipulated ranges, no action was indicated. Otherwise a need for immediate action was automatically signalled.

The situation in many companies is comparable to that faced by the Navy in this instance. We may know, on the average, how many of our products will be sold, but we are unable to predict with the desired accuracy what the specific

actual demand will be. Using this new theory, we can constantly check our anticipated demand against shipments and alter our manufacturing or purchasing plans accordingly. We need not wait for monthly, quarterly, or annual reviews of our sales forecast. Instead we can constantly recompute our reorder points and our manufacturing lot sizes, based on what is actually happening.

Integration of Forecasting Methods Through Operations Research

Since sales forecasting is based both on fact and judgment, it is not surprising that operations research has come to be of great value in this important area of a company's operation. The application of operations research to sales forecasting activities involves two points of view. It aids not only in supplying scientific and mathematical methods for developing the sales forecast but also provides for its use in an integrated plan for the management and control of the company's operations. First, let us see how scientific and mathematical techniques of operations research can be of assistance in determining the sales forecast. There are three general methods for forecasting sales. The first is the survey of executive opinion. This method results in a weighted average of the opinions of the top executives of the company from such areas as sales, finance, purchasing, production and administration. The second method, survey of sales force opinion, results in a weighted average of the opinions of various sales personnel ranging from salesmen to sales executives throughout the entire sales and distribution organization. A third, statistical or mathematical methods, supplements subjective judgment by objective methods based on factual and historical data. It makes use of correlation analysis which is a statistical method of determining the relationship between various pertinent factors affecting company sales.

There is also what might be considered a fourth method or multiple method approach. This combines the foregoing three methods, when applicable, into a weighted overall forecast by item or product group, and by territory or total company sales. Here operations research helps to determine which methods are workable in a particular company, how each of the methods can be used to cross-check the other and, finally, how the various forecasts can be weighted and combined into various forecasts by territory, product group, or individual product so as best to serve the purposes for which it is intended. Hence, the multiple method approach appears to be the most useful and versatile method of sales forecasting for most companies. The use of this method can best be illustrated by combining a number of actual case histories of its use into a single realistic example for simplicity of presentation.

An Example of Multiple Method Sales Forecasting

The XYZ Company, a manufacturer of a variety of products having seasonal demands, has a central factory which ships to regional warehouses which, in turn, ship to individual distributors or customers. Sales forecasting in this company fits into an integrated program for the management and control of company operations. The forecast is developed by three distinct methods. These methods are:

1. An opinion survey of salesmen and top executives.
2. A forecast by use of external indices such as gross national product, personal consumption expenditures, national income, personal income, disposable personal income, building construction, new housing starts, and other published indices of national or industry activity.
3. A statistical projection by product group and product of twelve months' moving averages of sales.

Long-range forecasts of five and ten years are made each year for long-range planning purposes. These forecasts are based on external indices of national and industry activity and on projections of company sales trends. A short-range forecast of one year is made each year and revised quarterly. This one-year forecast is of primary interest because it is used for coordinating sales with production and inventories on a company-wide basis. The one year forecast is constructed in the following manner: Several months before the beginning of the fiscal year a survey is made of the opinion of salesmen by sales districts and territories. They are provided with monthly sales and total sales figures for the past year by products and product groups. They are asked to estimate next year's sales for their territories or districts. At the same time, a survey is made of top executive opinion concerning next year's sales by regions and company totals. These forecasts are cross-checked and revised as they come up through the various levels of management. A fiscal forecast is then constructed for each product and product group for each territory and district and for company-wide sales.

While this survey is being conducted, a study is made of the correlation of several external indices with industry sales and company sales. These indices include, for example, new contruction, new housing starts, and kilowatt production by public utilities. Indices such as these have been found to be correlated with sales of different product groups. These external indices are published and forecast by government and other agencies and are used to forecast industry and company sales during the coming year for the product groups with which they are correlated. For example, suppose that sales of a given product group are related to a new construction index and that a ten per cent increase in the index is correlated with a five per cent increase in industry or

COMPUTATION OF CONTROL LIMITS FOR SALES, PRODUCTION AND INVENTORY CONTROL CHART

Month	Actual Monthly Sales	Cumulative Actual Monthly Sales (X)	Cumulative Average Monthly Sales (X_1)	($X-X_1$) Deviation Average From Actual	$(X-X_1)^2$ Deviations Squared
Jan.	392.0	392.0	1,109.78	717.78	515,208.13
Feb.	816.8	1,208.8	2,219.56	1,010.76	1,021,635.78
Mar.	887.8	2,096.6	3,329.34	1,232.74	1,519,647.91
Apr.	1,392.0	3,488.6	4,439.12	950.52	903,488.27
May	2,120.5	5,609.1	5,548.90	60.20	3,624.04
Jun.	885.5	6,494.6	6,658.68	164.08	26,922.25
Jul.	1,072.0	7,566.6	7,768.46	201.86	40,747.46
Aug.	867.5	8,434.1	8,878.24	444.14	197,260.34
Sep.	1,361.0	9,795.1	9,988.02	192.92	37,218.13
Oct.	1,314.5	11,109.6	11,097.80	11.80	139.24
Nov.	1,255.8	12,365.4	12,207.58	157.82	24,907.15
Dec.	952.0	13,317.4	13,317.36	0.00	0.00
Av. Monthly Sales =		1,109.78	Sum of Deviations Squared =		4,290,798.70

COMPUTATIONS

$$\text{Standard Error } (\sigma) = \frac{\sqrt{\text{Sum of Deviations Squared}}}{} = \sqrt{390,072.61}$$

$$\sigma = 624.55$$

$$\text{Coefficient of Variation } (v) = \frac{2 \times \text{Standard Error}}{\text{Av. Mo. Sales}} = \frac{1,249.10}{1,109.78}$$

$$v = 1.13, \text{ or } 113\% \text{ of Av. Mo. Sales}$$

$$\text{Control Limits on Forecast} = \pm \frac{\text{Annual Forecast} \times v}{12}$$

$$\text{On Forecast of 13,317, C.L.} = \pm \frac{13,317 \times 1.13}{12} = \pm 1,249.1$$

EXHIBIT 1

company sales. Then the correlation of company sales with industry sales is determined and the correlation of individual product sales with product group sales is determined. From these data, forecasts by products and product groups are developed. Correlation analysis thus provides an independent check on the forecasts obtained from the surveys.

Finally, a statistical projection based on a twelve months' moving average of sales by product and product group is made, using mathematical and statistical techniques which take into account seasonal fluctuations and long-term growth

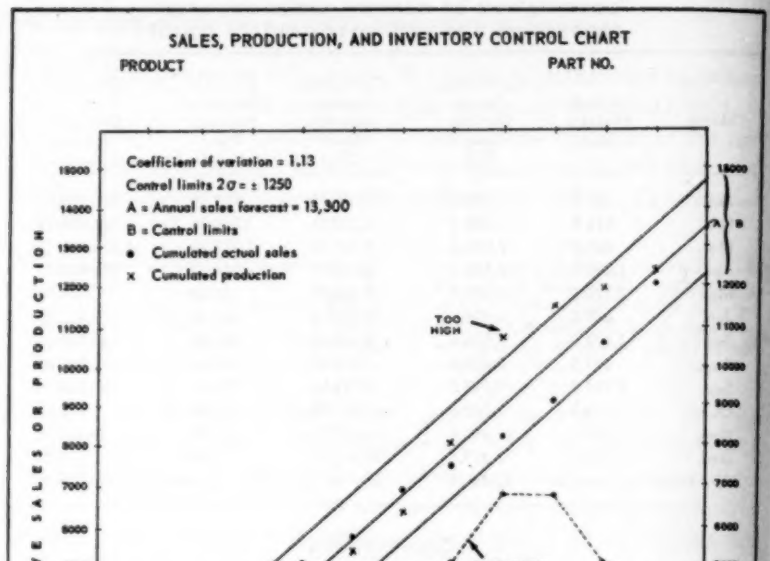
SALES, PRODUCTION, AND INVENTORY CONTROL CHART
PRODUCT
PART NO.
Coefficient of variation = 1.13
Control limits 2σ = ± 1250
A = Annual sales forecast = 13,300
B = Control limits
• Cumulated actual sales
× Cumulated production
TOO HIGH
INVENTORY
UPPER CONTROL LIMIT
LOWER CONTROL LIMIT
CUMULATIVE SALES OR PRODUCTION
TIME IN MONTHS
J F M A M J J A S O N D

EXHIBIT 2

trends. These three forecasts are then weighted according to a formula which achieves the best accuracy in forecasting past sales by product and product group. The final forecast is then used as a basis for scheduling production and inventories during the next year.

A Link Between Planning and Control

Let us illustrate how the final yearly forecast for a given product is used. Suppose the final forecast for a given item is for sales of 13,300 units. From the last twelve months' cumulative sales figures, the variation in sales between

months is computed in terms of what is called a "standard error" in the average monthly sales. This standard error determines the percentage of random deviations in the cumulative monthly sales for the product that will fall within control limits Exhibit 1 equal to the average monthly sales, plus or minus one or more standard errors. One standard error includes about 68 per cent of all random deviations, and two standard errors will include about 95 per cent. The latter is used in setting control limits on the forecast in this example. If actual monthly sales do not remain inside the control limits, we know the forecast will not be achieved, or will be exceeded, depending on whether the point goes out on the down-side, or up-side of the control band. Plotting actual cumulative monthly sales on such a Control Chart (Exhibit 2) enables management to budget production to match sales and thereby maintain inventories at optimum levels. When sales go out of control during the year, a new forecast is made based on a twelve months' average sales and a revised control chart is made up.

These control charts have many uses besides the coordination of production and inventory budgets with sales. They enable management to prepare financial budgets with known variances and carry out planning activities in many areas of the company. The sales forecast is the basis for budgeting net profit, for cash budgets, capital expenditure budgets and many other planning functions. The purchasing department uses the sales forecast as a basis for procurement activities and, of course, the sales department uses forecasts for many activities. Some of these uses are in sales planning, advertising, developing new territories and adjusting old ones, establishing bonus plans for salesmen and planning of promotional activities. Such controlled sales forecasts help to provide accurate and continuous monitoring of the operations of the company and are an important link in a modern system of management planning and control.

Statistical Testing of Relationships Used in Cost Planning and Allocation

by EDWIN W. GAYNOR

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When costs are projected into the future as a component process, in the total process of planning, the projection usually reflects the acceptance of stated relationships between one cost and another or between a cost and some other type of base. The degree of accuracy of these relationships then underlies the usefulness of the forecast. Here presented is a description and elucidation of statistical means—the co-efficient of correlation—to test the reliability of the relationship. A practical illustration is included, related to the forecasting of materials handling expense.

MAN HAS WRESTED from nature numerous secrets of the law that governs the behavior of natural phenomena but has not been nearly as fortunate in delving into the principles that govern the occurrences or the behavior of many of the varied and complex phenomena that make up our economic life. Nevertheless, we do attempt to use historical experience for this purpose. The problem at hand may be an attempt to forecast sales in terms of an expected increase in the birth rate or the spare parts requirement for a given volume of sales or perhaps merely next year's variable manufacturing expense.

It is academic but important to note that our results can be no better than the strength of the relationship between the element being forecast and the variable to which its behavior is related. This relationship is commonly referred to as correlation. Generally, in our cost forecasting, we have made only feeble attempts at evaluating the correlation of the variables involved. We have not made use of mathematical and statistical tools available for securing satisfactory results from forecasting plans. Among the more important of these questions are the following:

1. To what extent is the variable being forecast really related to the variable on which the forecast is based?
2. Is the relationship significant?
3. To what extent does the variation or incidence of the variable predicted depend upon the variation of the variable used as the basis for the prediction?
4. What generalization can one make concerning the population from which the sample group was selected?

In the paragraphs that follow an attempt will be made to show how the application of several proven techniques of mathematical statistics can be of

great assistance in developing satisfactory answers to the questions just posed, first in general and then as applied to an example for which the above four questions will be answered.

A Formula For Measuring the Strength of a Relationship

It must be understood at the outset that our discussion is limited to linear or straight-line relationships, i.e., values for two variables which if plotted on cross section paper will give points which can be connected by a straight line (or nearly so). It is fortunately true that many relationships in the economic or business field do follow a straight line. Our principal concern will be to develop a method of measuring the relative strength or goodness of relationships so presented.

Such a measure is called a coefficient of correlation. It is mathematically represented by the symbol r and defined by the following formula:

$$r = \frac{n \Sigma xy - (\Sigma x)(\Sigma y)}{\sqrt{n \Sigma x^2 - (\Sigma x)^2} \qquad \sqrt{n \Sigma y^2 - (\Sigma y)^2}}$$

In the application of this formula to cost forecasting problems, the symbol n will represent the number of accounting periods over which the dollar amounts of the variables x and y are to be measured. These variables may be any two accounting classifications having a logical relationship to one another. Σ is a symbol denoting "sum of." Σx will, therefore, be read as "sum of dollar amounts of variable x over the number of periods selected for measurement." The term "population" appearing in subsequent paragraphs will be used in its statistical sense as denoting the total number of accounting periods over which the relationship of the two variables has existed, and which could theoretically be used for measuring the degree of correlation if time permitted. Selection of any lesser number of periods results in a "sample," a term also to be used in its statistical sense in the remainder of this article.

The value derived by use of this formula is always between O and $\pm$ 1. As the value of r approaches O, we say that the correlation is weak or nonexistant. As it approaches 1 we conclude that the relationship is strong. We must understand, of course, that this expression of relative strength or weakness refers only to the linear relationship between the two variables. It is not to be inferred that a strong correlation between two variables automatically proves causation. The conclusion that a cause and effect relationship exists between two variables is the result of a logical rather than a mathematical

process. This is not to infer that the science of mathematics is illogical, only that particular expressions do not cover all facets of the situation. The coefficient of correlation does, however, provide an objective answer to the question, "Which of several alternative relationships derived from historical experience indicates the strongest linear relationship?"

Even though the value computed for r may indicate a relatively high correlation between the two variables, it is desirable to determine the probability of securing such a high value purely by chance from a population whose true correlation is actually considerably less or even non-existent. Inherent in such a test is the possibility of two types of errors:

1. There is a possibility of rejecting a hypothesis that really should have been accepted.
2. There is the possibility of accepting a hypothesis when it should have been rejected.

It is readily apparent that consequences of the first error are not nearly as serious as the second, so it is with this second type of error that we are concerned. Fortunately there are methods of evaluating this type of error.

The primary tool in this evaluation is the null hypothesis. It is based on the premise that it is much easier to prove a statement wrong than to prove that it is correct. Thus, if someone were to ask us to prove that all laws are just, we could not do so without investigating all laws. On the other hand, it would take only one unjust law to prove that the hypothesis is false. In determining the significance of the value secured for r, the coefficient of correlation, we employ the null hypothesis as follows. If the value r indicates a strong correlation, we assume that there is no correlation, that is, that the variation of one variable is not related to the behavior of the other, and then attempt to disprove it. The assumption is symbolically represented by $p = o$ and we conduct the following test:

1. Reject the assumption, $p = o$, if r is less than $-1.96/\sqrt{n-1}$, or if it is greater than $+1.96/\sqrt{n-1}$.
2. Reserve judgment if r falls between the two values.

The value $\pm$ 1.96 is secured from the "Student t Distribution" found in several statistical texts, for a significance level of .05 for samples of 30 or more. By significance level of .05, we mean that we expect 95 per cent of our data in the true population to fall within the $\pm$ limits indicated by the test. Had we selected a significance level of .02 or .01 our values would have been 2.32 or 2.57 respectively. The values that we have been discussing apply to sample sizes of 30 or more. As a practical matter, however, these same values can be used for smaller samples.

The mathematical value of the coefficient of correlation is of little practical

use unless we know exactly what we have. If $r = 0$, we know that there is no correlation between the two variables. On the other hand, if the value is ± 1, we know that all points fall in exactly a straight line and we can make extremely accurate predictions from the observed data. However, how do we evaluate the values between 0 and $\pm$ 1. They are, as a rule, more difficult to understand. The problem really centers around a determination of the degree to which one variable depends upon the behavior or variation of another and the degree to which chance or other factors control the variation. Thus, if the coefficient of correlation for the relationship between maintenance expense and labor hours is .80, we should very much desire to know just how much of the variation in maintenance expense is due to variation in labor hours. Fortunately, the refinements of mathematics provide a rather simple solution which is expressed by the term 100 r^2, or 100 times the square of the coefficient of correlation. Applying this to the value given above we can readily determine that 64 per cent, 100 (.80 x .80), of the variation in maintenance expense is due to the variation in labor hours. Had the value of r been only .40, we could conclude that only 16 per cent of the variable, maintenance expense is dependent upon the variation in labor hours.

The technique employed in securing the coefficient of correlation is essentially one of sampling. As a result, we are faced with the problem of generalizing or estimating the correlation of the entire population of relationships from which the sample was selected. This admittedly is not an easy task because of the complex nature of the distribution of r. Here again, however, in a statistical table commonly referred to as "95 per cent confidence limits for the coefficient of correlation" is the source for our solution. If we know the sample size and the coefficient of correlation, we can determine by use of this table the limits between which 95 per cent of the r's would fall in the true population. Thus, if a sample of 25 observations produced a coefficient of correlation of .90, we could readily determine that, in the true population from which the sample was selected, the values for the coefficient of correlation would fall between .75 and .95 and we could be sure of this 95 per cent of the time. As the sample size decreases, of course, the computed coefficient of correlation becomes progressively less reliable and the range of the r's of the true population tends to indicate a wider span.

Application of Theory to Forecasting Materials Handling Expense

As an illustration of this technique, there is presented below an example involving the selection of an appropriate criteria for the purpose of forecasting

a given cost. For many years the company in question had forecast material handling expense in terms of anticipated material purchases. For the past several years, however, the forecasts proved quite inaccurate and required, as a result, rather serious mid-year budget adjustments. It was decided to study the matter and attempt to develop a more acceptable basis. After some study and investigation, it was concluded that a choice would have to be made between materials purchased and direct labor as a logical basis for forecasting materials handling expense. The primary reason for this conclusion was the fact that these were the only two elements for which historical information was available for a considerable period of time. The use of any other element would have required considerable research and accumulation of historical data, a task which would be laborious and also prohibitive from a cost standpoint.

At this point, however, a rather natural dilemma developed. How should the decision be made to determine which of the two bases, direct labor or material purchases, is the more appropriate? In spite of the fact that all parties agreed that it was an unsatisfactory basis for forecasting, the supporters of material purchased contended that, since the expense was incurred for the acquisition and handling of productive material, it was quite obvious that some measure of material acquired or used was the most reasonable and logical basis for forecasting the expense of handling it. However, inasmuch as units of weight or physical count could not be availed of to apply this basis because of wide variation in the physical attributes of the various elements of material purchased, it would be necessary to use dollar value of materials purchased.

MATERIAL HANDLING EXPENSE, MATERIAL PURCHASES, AND DIRECT LABOR FOR 10 PERIODS

Period	Direct labor	Material purchases	Material handling expense
1	$9,500,000	$3,200,000	$ 525,000
2	9,800,000	4,100,000	498,000
3	7,900,000	3,900,000	460,000
4	5,500,000	2,700,000	395,000
5	6,000,000	2,500,000	400,000
6	3,750,000	1,900,000	326,000
7	4,000,000	1,000,000	301,000
8	2,200,000	1,300,000	305,000
9	875,000	1,800,000	238,000
10	1,900,000	1,900,000	240,000

EXHIBIT 1

COMPUTATION OF THE COEFFICIENT OF CORRELATION FOR THE DATA PRESENTED IN EXHIBIT 1

Period	Direct Labor X	Materials Handling Ex. Y	X^2	Y^2	XY
1	9.5	5.25	90.25	27.56	49.8
2	9.8	4.98	96.04	24.80	48.8
3	7.9	4.6	62.41	21.16	36.3
4	5.5	3.95	30.25	15.60	21.9
5	6.	4.	36.	16.	24.
6	3.75	3.26	14.06	10.62	12.2
7	4.	3.01	16.	9.06	12.
8	2.2	3.05	4.84	9.30	6.7
9	.87	2.38	.76	5.66	2.
10	1.9	2.40	3.61	5.76	4.5
	51.42	36.88	354.22	145.52	218.2

$n = 10$

$\Sigma x = 51.42$

$\Sigma y = 36.88$

$\Sigma x^2 = 354.22$

$\Sigma y^2 = 145.52$

$\Sigma xy = 218.2$

$$r = \frac{10(218.2) - (51.42)(36.88)}{\sqrt{10(354.22) - (51.42)^2}\ \sqrt{10(145.52) - (36.88)^2}}$$

$$= \frac{285.64}{29.98 \cdot 9.75} = .98$$

EXHIBIT 2

The proponents of direct labor were convinced that direct labor cost was a more logical and reasonable basis for forecasting material handling cost. The problem then was to find a method of evaluating these contentions.

Research and investigation of the matter disclosed the existence of the mathematical devices which are the center of attention in this article. The solution was developed from accounting and purchasing records maintained in the normal course of operations and required no unusual effort. Exhibit 1 presents the historical data selected for the test. Exhibit 2 illustrates the first step in the evaluation, that is, the computation of the coefficient of correlation for the two variables, direct labor and materials handling expense. In a similar manner, the computation was made for the two variables, material purchased and material handling expense. The results of both computations were as follows:

Coefficient of correlation:

Between direct labor and materials handling expense	.98
Between materials purchased and materials handling expense	.85

Admittedly the correlation between expense and each of the two alternatives is quite significant, i.e., either has value as a forecasting base. Applying the criterion previously discussed, that the closer the value for r approaches one the greater is the indicated correlation between the two variables, it was readily concluded that there was a greater correlation between direct labor and materials handling expense than between material purchased and materials handling expense. It was recognized, however, that there was the possibility that a value for r as great as .98 could be secured purely by chance from a population of relationships in which there was actually no correlation between direct labor and materials handling expense. The problem raised by this consideration was solved by use of the significance test discussed previously, that is, the null hypothesis. It was thus assumed that there was no correlation between the two variables ($p = 0$) and an attempt was made to disprove the hypothesis by the criterion:

Reject the hypothesis that $p = 0$, if .98 is less than

$$-1.96/\sqrt{10-1}$$

or if it is greater than

$$+1.96/\sqrt{10-1}$$

Reserve judgment if .98 is between the two values.

The required values were computed as follows:

$$\pm 1.96/\sqrt{9} = \pm .65$$

Since the value for r (.98), is greater than .65, the null hypothesis was rejected and the conclusion was drawn the $r = .98$ indicated a significant correlation between direct labor and materials handling expense. Notice that the value $r = .85$ secured for the relationship between dollar value of material purchased and material handling expense also indicates a significant correlation.

After being satisfied that the indicated correlation between the two variables was significant, it was decided to follow on to the step of determining just how much of the variation of materials handling expense depended upon the variation in direct labor. For this purpose, the formula $100r^2$ was employed. The calculation 100 (.98 x .98), indicated that 96 per cent of the variation in materials handling expense was due to variation in direct labor and 4 per cent was due to chance or other factors. Similarly, it was determined that 72 per cent of the variation of material handling expense depended upon the variation of the dollar volume of material purchased while 28 per cent was due to chance and other factors. It was thus quite apparent which of the two alternatives appeared to govern the incidence of material handling expense.

The one remaining problem at this point was the necessity for making some generalization concerning the entire population of direct labor and materials

COMPARISON OF RESULTS OF TESTS PERFORMED TO DETERMINE THE CORRELATION

(Between the variable, material handling expense, and the variables direct labor and material purchases.)

	Direct Labor	Material Purchases
In terms of the coefficient of correlation, to what extent is materials handling expense related to the indicated variable?	.98	.85
Is the indicated relationship significant?	Yes	Yes
To what extent does the variation of materials handling expense depend upon the variation of the indicated variable?	96%	72%
What is the range of the coefficients of correlation of the population from which the sample was drawn?	.95 to .98	.45 to .95

EXHIBIT 3

handling expense relationship. Step five was used for this purpose by employing the "table of 95 per cent confidence limits for the coefficient of correlation." Referring to this table it was determined that the sample for which a value of .98 was developed, was drawn from a population whose true r's would fall between .95 and .98, 95 per cent of the time. In a similar manner, the limits of the alternate relationship with a value of .85 were determined to be .45 and .95.

Exhibit 3 presents a tabulation of the results of the several tests to which the two relationships were subjected. It is obvious which of the two alternatives would prove more reliable for purposes of cost forecasting. Direct labor was selected and used. Review of results in subsequent years proved the propriety of this decision.

Steps in Performing the Tests

This at first may appear a rather complicated and somewhat arduous way to arrive at a decision. It might even be suggested that the same decision could have been reached by any intelligent individual without resorting to the techniques described. Perhaps, but we must recall that, in the case just described, we had two intelligent individuals each thoroughly convinced that his solution was correct, one holding that direct labor was the proper criteria while the other was convinced that dollar value of materials purchased was the logical base upon which materials handling expense should be forecast. As is the case in many other applications of statistics and mathematics to business problems, one of the great benefits to be derived in this case is the ability of these techniques to distinguish between several "obviously correct" solutions.

Before concluding, let us review the several steps which are necessary in performing the tests described. Logically, the procedure should be developed as follows:

1. Secure historical data for as many past periods as possible for each of the alternatives to be considered.
2. Compute the coefficient of correlation (r) by use of the following formula:

$$r = \frac{n\Sigma xy - (\Sigma x)(\Sigma y)}{\sqrt{n\Sigma x^2 - (\Sigma x)^2}\quad\sqrt{n\Sigma y^2 - (\Sigma y)^2}}$$

3. Determine the significance of the results by use of the null hypothesis ($p = 0$) and prove or disprove this hypothesis by the criteria:
   a. Reject the hypothesis $p = 0$ if r is less than
   $$-1.96/\sqrt{n-1}$$
   b. or if it is greater than
   $$+1.96/\sqrt{n-1}$$
   c. Reserve judgment or if r is between these two values.
4. Determine the extent to which the variable predicted depends upon the variation of the base used for the prediction by the formula: $100r^2$.
5. Make a generalization concerning the entire population of relationships from the results of the sample by use of the "table of 95 per cent confidence limits for the coefficient of correlation".
6. Tabulate the results and accept the indicated decision.

No attempt has been made to prove the validity of the various statistical formula described and used in this article. That is a task properly reserved for a more formal and academic classroom presentation. We have merely discussed the application of mathematical laws and theories to forecasting problems in general.

It must be reiterated that these techniques are not a substitute for sound business judgment, nor are they suggested as a substitute in situations where other considerations are paramount. They are, however, an answer to the problem of evaluating alleged, assumed or proposed relationships so often described by such equivocal terms as "most suitable", "reasonable", "equitable", or "logical". And there is one word of caution to be given. The fact cannot be over-emphasized that, all along, we have been discussing techniques applicable to straight-line or linear relationships. Where graphic presentation of data indicates a relationship other than straight-line (or reasonably so), techniques other than those described must be used.

Forward Planning the Planning and Control Tools

by LINDEN C. SPEERS
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A habit of looking ahead toward improving the means by which accounting information is developed and made useful in management will, suggests the present author, redound to the benefit of the company's total planning endeavor. He relates the accounting system, equipment, and reports to the control and decision-making processes and describes ways of making sure that accounting information is accurately, flexibly and promptly developed.

ORIGINALITY AND FRESH ideas are most important virtues in systems planning. If his planning is to mesh with company planning problems, the accountant should start with the factors or operations which are most significant to the overall profitableness and stability of the business on the control side. In many situations, a relatively few control points may afford management a large part of the potential benefits of an elaborate system. In the small plant, for example, a simple comparison of finished units completed per day against a standard may afford adequate control over labor cost and plant utilization. In the larger and more complex venture, it may be desirable to measure the output at the level of individual operations against a standard in order to exercise suitable control. In another instance the same degree of control may need to be exercised in each of the firms, for principles hold true throughout, e.g., in the two person office, it is as essential to segregate the duties to provide adequate internal control over the cash receipts as it is in the multiple-person office.

As the accountant evaluates his task, he should set his sights with the broad managerial responsibility in mind. He should first consider what assistance can be developed through the accounting function in attaining the key objective. This consideration will require a comprehensive analysis to answer, to the best of his ability, questions such as:

1. What are the company's particular problems?
2. What is their relative importance?
3. What information is needed to cope with these problems?
4. Is such information presently available?
5. Is it being used?
6. Can lacking information be obtained practicably?

Next, he should give consideration to the accounting tools that are available for providing the needed information and how they should be designed, revised and administered. The strides of industrial progress require a continual

evaluation of the fulfillment of accounting responsibilities. An adequate program today may start to become obsolete tomorrow.

Few businesses are static. This dictates that the accounting system must continually be reviewed to determine whether modifications and refinements are desirable. Progressive executives are always looking for better information on which to base decisions. Changes demand an adequacy review. Internal and external occurrences which effect the system frequently, include:

1. Changes in the problems of the business.
2. Changes in the physical layout or size of plant.
3. Changes in methods of purchasing or manufacture.
4. Changes in ability of office or executive personnel.
5. Changes in the use of control information.
6. Changes in outside regulatory requirements.

Planning the Accounts and the Procedures

Continuous forward planning review, not urgency patch-up treatment, should be the lot of the accounting system with and through which the accountant must work. It must take on the character of critical analysis. The chart of accounts is the heart of the system. It should be designed to provide for industrial growth in an orderly and systematic manner. The account numbers, for example, should be assigned so that new accounts can be inserted in a logical arrangement without requiring the shifting of numbers or suffixing with letters. There is no particular advantage to using numbers in a strictly consecutive order, but there is a tremendous advantage for the accounting staff and operating personnel in not having to repeatedly learn account numbers. Also when the chart is originally designed or revised, the numbering arrangements should be planned to permit a shift to mechanical or tabulating equipment without major revision in account numbers and should be arranged to facilitate the preparation of reports directly from the ledger, classifying controllable expenses in separate accounts. Information included in an account should not require subsequent analysis for separation, yet excessive detail should be avoided. This is especially true in the small company which may not have the caliber of personnel to properly operate a complicated plan or a management with sufficient breadth of understanding of accounting to use it effectively. The danger of over-elaboration is applied particularly to standard cost accounting systems. It is often better to start with less than a complete cost system and forward plan to a complete one. Procedures are the pipelines through which flows the accounting information to the accounting department—and measures also the information available for elementary reports. The task of establishing or revising a procedure

PROCEDURE REVIEW - ORDER-BILLING CYCLE

1. Obtain a copy of each order or order-billing form in use for products and service orders and,
   a. Follow the flow and disposition of each copy.
   b. Denote time of entry for each entry on the form.
   c. Determine the extent of "special" instructions required.
   d. Special billing instruction requirements for certain customers.
2. Examine a representative group of orders, invoices and credit memos and determine:
   a. The per cent of invoice and credit memo amounts for various dollar ranges. (i. e. $5-$10-$15, $15-$30, etc.)
   b. The cycle time between receipt of the order and shipping date.
   c. The per cent of subsequent changes.
   d. The per cent of credit memos to billings.
   e. The per cent reasons for credit memo issuance.
   f. Back order frequency.
   g. Whether credit memos relate or refer to specific invoices.
3. Examine customer or receivable files and determine:
   a. Whether a large per cent of business is with a small per cent of customers.
   b. Frequency of orders and amounts by large and small customers.
   c. Whether customers generally pay by statement or by invoice.
   d. The total number of accounts and the average number of open accounts.
   e. The extent of partial payments.
   f. The extent of repetitive and nonrepetitive customers.
4. Determine the extent and method of special handling of:
   a. C. O. D. shipments.
   b. Export shipments.
   c. Special cash sales.
   d. Special discounts or allowances.
5. Determine what data is available concerning sales analysis:
   a. By territory.
   b. By product.
   c. By customer.
   d. For quantity discounts.
   e. By product end use.
   f. By industry.
6. Obtain and examine copies of all regulatory or government reports required. Determine whether special regulations are applicable.
7. Determine the extent of special billing formats used by special customers.
8. Determine whether engineering or tooling, etc. is billed separately.
9. Determine how outgoing freight is handled.
   a. If company operates own delivery facilities, examine accounting and control.
   b. Obtain details on freight allowance schedules and policies.
10. Examine method of handling consignments.
11. If branch of field inventories are used, examine method of billing and control.
12. Examine the pricing policy for irregularities or exceptions.
13. Examine the commission structure for:
   a. Standardization - product and per cent.
   b. Split territories and over-rides.
14. Determine when and why peak loads exist.
15. Examine the methods of maintaining stock records to determine customer inquiries as to:
   a. Whether stock is available.
   b. When it will be available.
   c. What the exact status of the order is.
16. Obtain or sketch copies of all records, forms or control boards and indicate:
   a. Flow and timing of each copy.
   b. Average entries per copy.
17. Thoroughly examine product numbering system. Determine whether it contains significant digits, such as:
   a. Stock location.
   b. Style - Color, size, etc.

EXHIBIT 1

so that it will be adequately forward-looking requires an extremely thorough analysis of all of the facets of the business which might affect or be effected by it. A specific accounting procedure can be likened to a cogwheel with teeth

which mesh into several other procedures. A forward planning review requires that all be examined as to how they will mesh with the over-all forward planning program of the company. For illustrative purposes, the kind of analysis that would have to be made in reviewing an order handling—billing—receivables procedure is shown in Exhibit 1. How analytical would you be in your review approach? Just covering one or two of the points might temporarily plug the trouble spot, but this develops into a costly patch-on-patch method and contains no element of forward planning.

Should procedures be written? Certainly this is an aid in training new personnel, and helps to reduce the misunderstanding of instructions. Yet written procedures are costly to prepare and difficult to keep-up-to-date. If used, they should be kept as simple as possible. Perhaps they should be used on major or selected where the potential advantages will be the greatest. Written procedures become a necessity when direct supervision and observation cannot be effected.

Planning the Forms and Accounting Equipment

Forms are literally the frames around which paperwork procedures are built. Consequently, significant changes in procedures usually obsolete forms and significant changes in forms requires procedure revision. Since practically all clerical costs center around the processing of forms, the proper design and use of forms offers the greatest area for keeping clerical costs low. In designing a form it is desirable to make a check list of all of the things the form should accomplish. Such a listing will afford the means for determining the information needed on the form, the writing sequence, the arrangement of the data, and the number of copies.

The use of a simple form process flow chart is one of the best ways to check on the efficiency of the handling and progress of a particular form. The chart is a visual aid which can be readily understood and is sure to disclose needless steps, backtracking and excessive copies. It is in the area of the use of forms in which the greatest potential for work simplification lies. Keep your forms remodeled to promote clerical efficiency. Do not hesitate because of the quantity on hand to send the obsolete ones to the scrap heap. Evaluate the economics of the matter. Do not change for the sake of change alone.

In form designing, the following steps and points should be forward planned as far ahead as possible in the company's program:

1. Select a title which clearly indicates the purpose of the form.
2. Use a simple identification system for coding the form and revisions.
3. Standardize to standard paper and filing sizes.
4. Select quality of paper based on use of form.

5. Determine number of copies and method of duplicating information, i.e., one-time carbon paper or duplication equipment.
6. Consider pre-numbering where internal control is desired.
7. Use different colored paper or printing to identify copies.
8. Label copies to show use and destination.
9. Print constant information and make captions as descriptive as possible to keep amount of variable information to a minimum.
10. Use check boxes to reduce writing.
11. Arrange data in order in which it will be subsequently used.
12. Space the lines and boxes as required by the writing method, i.e., manual, typewriter, bookkeeping machine, or punched card equipment.
13. Position name and address for window envelope mailing.
14. Allow necessary margins for printing requirements, writing method requirements and filing method.
15. Design different but related forms with identical arrangement of basic data to permit use of duplicating masters to write basic data.

As to equipment usable by accountants, forward planning is now "all the rage". Developments in the area of electronic computers insure tremendous advances in the processing of volume data. However, for most of us, when we steer clear of the fanciful dream world of push-button devices to do our work, we find that our practical range of tools runs from the manual method to low cost tabulating equipment. Mechanization carefully applied to office procedures is an essential to progress as mechanization of production facilities, but we should remember that there are still some jobs to be done today which can be done better manually. The equipment area is one which offers great potential in forward planning the tools of the system. A projection of estimated equipment needs should be made as far into the future as possible. Changes in equipment have a substantial impact on personnel and space requirements and these should be planned as far ahead as is practical. One of the major problems in connection with mechanization is the standardization of procedures. At the earliest possible date in the company's development and long range planning, the accountant should put his weight behind standardization of the procedures which would affect future mechanization. Examples of items to tackle are non-standard pricing, illogical pattern or duplication of product numbers, or more than one number for the same item.

The real comparison to be made, when deciding upon a change in equipment, should be, not between the present procedure on the present equipment and the proposed procedure on the proposed equipment but between the best procedure on the present equipment and proposed equipment. Further, all too often, equipment acquisition decisions are justified solely on a matter of economics. While, certainly, cost reduction is a major factor to consider, it can be overstressed. If the proposed savings does not materialize, an unhappy atmosphere will likely develop, or the cost saving many prove out but an untenable bottleneck may develop somewhere along the procedure line. Additional values

to be derived from more information, faster information, and better information may be worth more than an immediate cost reduction.

In forward planning the equipment requirements, the following major steps and points should be considered:

1. Estimate present and future volume of work under existing method.
2. Estimate present and future volume of work under proposed method.
3. Compute and compare cost under each method. Consider salary cost, equipment depreciation, space cost, forms cost. Determine actual savings against theoretical savings.
4. Project timing schedule.
5. Project peak-load problems.
6. Consider present and future space requirements.
7. Consider breakdown interruptions and flexibility of method.
8. Review present and future personnel requirements and problems.
9. Consider appearance of resulting product.
10. Consider value of additional data developed.
11. Project transition problems.

Planning the Reports

Reports and charts are the end results or, we might say, the finished tools of the accounting system. Industrial management, in keeping abreast and looking ahead, has a critical need for the action-motivating type of report which is the product of an effective plan. Such reporting can be characterized as providing a third dimension to management. Only in rare instances will the strictly historical report furnish a basis for sound decisions. Even for control alone, a report must present results against a planned objective. Without a planned performance there is nothing to effectively report against! The planned system through its control reports, provides a sort of quality control check on performance and ultimate financial results. The essential characteristics of a good control report are:

1. A title which clearly states what is being reported.
2. Timeliness in issuance.
3. The period being reported on.
4. Comparison of actual performance against a planned or standard performance, with the variation being simply and clearly presented.
5. Reason for variation and recommended action, if possible.

Only useful reports, vital to some phase of the enterprise, should be issued. Busy executives should not be flooded with a mass of bulky reports which require much of their valuable time to sift out the significant data. Useful reports should be used. The control type of report should be used in reporting the range of activity from individual cost center performance up to and including the earnings statement—in other words, to all levels of the management team. Always the thought should be: how does performance against the plan for today relate to planning and performance tomorrow? Good control reports are dynamic management tools because:

1. Planned performance permits effective measurement. Each procedural cycle is a link in the industrial chain. Control reporting provides a prompt measurement against an expected standard. It is a disaster preventive tool.
2. Planned performance permits management by exception. Obviously there is no need to bother busy executives with countless repetitive reports of phases of activity unless the variation deviates from an agreed tolerance.
3. Planned performance has a self-disciplining or self-correcting effect upon actual performance. Each department head knows that, if his department's unfavorable performance variance is out of line, it will be reported to his superior. The natural tendency is for each person responsible for a phase of activity to act promptly on the control reports issued to him in order to prevent an unfavorable report being issued higher up.
4. Control reports provide a sound basis for management action. Actual performance is measured against planned performance. Without measurement against a plan, there is no logical basis for directive decision.

Extreme care should be used in the selection of data and method of presentation to the various levels of the management group. The statement that a factory department had a performance efficiency of 75 per cent may have meaning to an accountant but will it to the foreman? Perhaps he will understand better if we tell him his department only turned out 75 pieces in an hour instead of the goal of 100. The use of charts helps to get around the problem of the inadequacy of words and should be an important component in a well planned program of dynamic reporting. Extreme care should still be exercised in the selection of the data and the method of presentation. Reduce the presentation to the language the recipient understands.

Summing Up

The forward planning responsibility of the industrial accountant is the responsibility to make the accounting function a more useful management tool for planning and control. This will be accomplished through a practical accounting system, realistically administered. The tools of the accounting system must constantly be inspected, sharpened, oiled, modified. The accounting product must be properly packaged and labeled. The accountant must possess the qualities of originality, alertness, thoroughness, must have drive and display tact, must possess an inventive and an analytical mind and be a master salesman. Perhaps most important of all, he must forward plan the tools of the system. Coordinated forward planning is essential to industrial expansion on a sound financial basis.

Planning What Your Cost Analyses Will Cost

by DAVID F. QUINN

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It seemed a dubious thought at first that the activities of a cost analysis section would be subjected to a budget and the initial suggestion that, since work orders are the medium of cost analysis, they would serve as a budget base, seemed an equally doubtful proposition. How this base was tailored to serve the purpose is narrated in this article.

THE COST ANALYSIS section is the company's key cost reporting group. It is responsible for the policing and analysis of an intricate parts cost system. This section publishes frequent current product cost reports, prepares price redetermination schedules, prices contract termination claims, prepares manufacturing budget forecasts, and prepares quotations for follow-on business. In view of this diversity, I reacted distinctly unfavorably when told that the cost department, heretofore measured as a unit by work order activity, was to have a budget for each functional group within it and that each group would have its own unit of measure. It did not make sense to me to budget a cost analysis group. There were strong reasons for my reaction. Our company enjoys a widely diversified product mix and does business under all type of contractual and pricing agreements in both military and commercial aircraft and aircraft parts.

The interpretation of the parts cost system is the most important function of the cost analysis section. Therefore, to explain the relationship and importance of the section to the company's overall scheme of cost control, it is necessary first to explain the parts cost system. Establishing the smallest detail segment as well as the final assembly operation of all segments of a shippable item as entities to be costed separately is the basis for the system called parts cost. Cost records are established for each shop-ordered lot of each detail part, subassembly and final assembly of all shippable or "saleable" parts. Costs are accumulated and analyzed by element, that is, labor dollars, material dollars and outside production dollars. Costs are reported on individual details on an exception basis where manufacturing difficulties occur and as summaries of the costs of "saleable" items upon shipment, as a matter of routine.

A Work-Orders-Analyzed Base?

The difficulty of establishing a unit of measure to budget this group was inherent in the variability of tasks performed. There was, however, one common

COST ANALYST'S TIME SHEET

NAME _____ W/E SUMMARY _____

COST REPORTS Part No.	Model Code	MON.	TUES.	WED.	THURS.	FRI.	SAT.	TOTAL	REMARKS
1. 227646	68	6.0	4.0	6.0	6.0			22.0	Completed 10/13
2.									
3.									
4.									
Cost of Sales Terminations		1.0	1.0					2.0	
Total Input			1.0	1.0				2.0	
Shop Inventories Schedule Trans. Estimates		1.0		1.0				2.0	
Redeterminations Hours Reports Other(Explain Below)			2.0		2.0	8.0		12.0	
TOTALS		8.0	8.0	8.0	8.0	8.0		40.0	

EXHIBIT 1

denominator for all of our work, the cost record or "work order", as we call it. In most of the work a cost analyst performs, he must look at and analyze a work order. In the past, the number of work orders issued had been used successfully to budget the cost department as a unit. In a parts cost system in an aircraft factory, there can be, and are, at any one time many thousands of work orders open in the system, indicating a possible sensitive measure of a variable work load. But no correlation exists between work order activity and the work of the cost analysis section. For example, in the beginning of a large airframe component contract, we might open 5,000 individual cost records to make fabricated details, and cost analysis would not be performed on the records for four to five months. Yet, work order activity would indicate a need for more cost analysis personnel at the moment.

In further considering our common denominator, work orders, it was suggested that the number of work orders analyzed in the preparation of product cost reports would be the activity indicator which had the most correlation with the work of the cost analysis section. A general proposal was then made to the budget department. Why not keep a count on work orders analyzed and relate it to hours worked to develop a unit of measure as in the formula:

$$\frac{\text{Total work orders analyzed}}{\text{Total cost analysis hours}} = \text{Work orders analyzed per hour or unit of measure}$$

At this point, the fact that it takes more time to analyze work orders for jet engine components, for instance, than it does to analyze air frame work orders was pointed out. Further study showed that there was, indeed, a wide range of time required to analyze individual orders. To overcome this as an obstacle,

it was suggested that, from experience and judgment, we weigh work orders within our three basic product types in the following manner:

Product Type	Weight Work Orders to be Given
A	1.0
B	0.5
C	3.0

During the initial conference, the budget department agreed to study work orders analyzed as a unit of measure. With their cooperation, it embarked on the following course:

1. A six months base period was to be studied to develop the factors to use in the formula:

$$\frac{\text{Work orders analyzed}}{\text{Analysis hours}} = \text{Unit of measure}$$

2. To develop the needed data, cost analysts would keep elapsed-time studies. (This we had been doing for another purpose. Therefore, the study could be made retroactive and proof of the unit of measure would not be delayed for new elapsed time studies.) Exhibit I shows the weekly record kept by the cost analysts.
3. From data on the cost reports indicated completed on Exhibit I, the budget analyst referred to the cost report work sheets and counted the number of work orders analyzed.
4. A summary of the total work orders analyzed was made by product type and weighted on the weights factors previously set forth above.

The total hours worked by the section were picked up from payroll and a procedure was established by the tabulating section to furnish the budget department with this information monthly. This data from the six months base period, gave us both the numerator and denominator of our formula. Substituting figures in the formula, as given in (1) above, we found that it worked out to:

$$\frac{13576}{5303} = 2.56$$

Trouble With the Figure Developed

At this point we were all startled by the results and the allegation of the computation that our section was analyzing work orders only at the rate of 2.56 per hour. To find the reason for this seeming inaccuracy, we further analyzed the summaries which had been made of the analyst time record. This showed that cost analysts were spending only 50 per cent of their total time on product cost reports. The remainder was being spent on special input reports for customers, special product projections for management, price redeterminations, and terminations. Add to this the fact that, of the thirteen people in the section, only nine were keeping time records (the other four include two supervisors and two comptometer operators). Our problem was clear. Only 50 per cent of nine/thirteenths of our total time, or 35 per cent of our effort, was going into our unit of measure formula denominator, whereas 100 per cent was going into the numerator.

The budget department argued that we shouldn't worry about the unit of measure being low in productivity indications. It was contended that this factor was developed over a long enough period of time to equate all irregularities and that the same percent of non-cost-report work (65 per cent) should hold true in the future, as it did for the base period. Hence, if we maintained the same performance during the next six months as during the base period, we should show 100 per cent realization against our budget (or whatever realization was set as unity). The budget staff also showed us what our budget results would have looked like in the base period. In three of the six months involved, we were over the budget and, in the other three, we were under. We argued that any given month could show a major distortion by the shifts in work caused by price redetermination cut-off dates alone. When a price redetermination cut-off date passes, the efforts of one to four cost analysts (the number depending on the complexity and size of the product) are directed to preparing special cost schedules to submit to the customer for re-pricing purposes. Prior to the cut-off date, the activities of those working on the price redetermination are concerned with cost reports and hence would be productive of units of measure. After that date, they would, suddenly, be producing no units of measure. The month's performance against the budget would show the cost analysis section with 60 per cent realization, or over-budget by three men.

Adjusting the Formula for a Truer Picture

Because of this and other contingencies which might cause big monthly distortions, the following agreement was reached to modify our budget:

1. Due to the monthly variability of the hours between cost reports and other reports, the budget department would:
   a. Get a monthly report of hours spent by cost analysts on reports other than product cost reports, such as price redeterminations which involved the analysis of work orders.
   b. Convert these hours into "work orders analyzed" at the base period rate of 2.56 work orders per hour.
   c. Add the total work orders converted in Step b to the total units of measure produced during a month by "work orders analyzed" and arrive at a new total. This new total would be our units of measure produced, or actual budget generated for the month.

As a result, the work of the cost analysis section is reflected in the Budget Report shown as Exhibit 2. Without going into detailed analysis of the report itself, it should be mentioned that it is in the same format as budget reports on all of our company's indirect departments, with the difference that this is a report on a sub-group of the cost department. Therefore, certain information, such as the overhead-not-budgeted category, is left blank. Differences in realization due to our work load smooth out over a three-month period, which is the

THE RYAN AERONAUTICAL CO.
BUDGET REPORT APRIL, 1956

Division: Controller's
Department: 708 - Cost Analysis Section
Supervisor: D. F. Quinn

Sample

Unit of Measure: Work Orders Analyzed and Special Reports

	Month			Fiscal Year To Date		
OVERHEAD BUDGETED	Budget	Actual	Variance	Budget	Actual	Variance
Labor	$ 6,754.	$ 7,192.	$ - 438.	$39,785.	$41,312.	$ - 1,527.
Total	$ 6,754.	$ 7,192.	$ - 438.	$39,785.	$41,312.	$ - 1,527.
OVERHEAD NOT BUDGETED						
Acc'ts. Controlled by Labor						
All Other						
TOTAL DEPT. OVERHEAD EXPSE.		$			$	
INDIRECT HOURS WORKED		2,101			11,590	
UNITS	4,748	4,475	- 273	26,193	25,424	- 769
UNIT REALIZATION		94.3%			97.1%	

ANALYSIS OF BUDGETED OVERHEAD VARIANCE

	Labor	Expense	Total	Labor	Expense	Total
BUDGETED VARIANCE DUE TO:						
Unit Realization	$ - 412.	$	$	$ - 1,203.	$	$
Premium Overtime	- 26.			- 324.		
Other						
Total	$ - 438.	$	$	$ - 1,527.	$	$

	Month	3 Month Moving Average
EMPLOYEE VARIANCE (Based on 40 Hour Week)		
Equivalent Employees Based on Hours Worked	12.5	12.2
Equivalent Employees Required, Based on Units	11.8	12.4
Variance	- .7	.2

COMMENTS:

EXHIBIT 2

most important reporting period on the exhibited report. This proves to be the most effective statistic on the budget report because it can be used with conviction either by management, in the event that a negative variance occurs, to prod supervision into increasing output or give up a man, or by supervision, in the case of a positive variance, as a total in obtaining more manpower for which the budget has proved a need.

Successful application of the budgeting concept to such a function as cost analysis is an indication to us that there are few limits to the areas to which variable budget coverage can be extended. In particular, this thought is leading us on to the application of budgetary planning to staff areas long neglected in this respect.

Using an Index to Anticipate Impact of Cost Changes

by KEITH LISTEBARGER

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While publicized cost increases are rising up to the company level from one tier of suppliers to another or while a round of wage increases is taking effect in prices of materials or perhaps directly in a company's own labor costs, the final effect cannot be read in the company's current cost figures. It is at this point that the present author would bring a price index into play. In the accompanying article he indicates how such an index may be constructed and used.

IN THESE TIMES of constantly increasing costs of labor and material, it is becoming more and more important to be able to recognize the impact of any such increases on total cost. Most companies, when confronted with increased costs, will, if possible, raise selling prices to absorb the increase. However, it becomes more difficult as competition grows keener to pass on increased costs to the customers.

In any event, before management can make an intelligent decision it is necessary that it determine both the present and the near future effect of cost increases. Management needs a tool to enable it to measure the effect of cost increases and their resulting impact on profit. This is not easy to come by. For example, many major price increases in material result directly from an increase in the price of steel and from the wage pattern set by the steel industry. However, it may be three to four months before all related cost increases are reflected by allied vendors.

Estimating may be resorted to. If a company is in a position to increase selling prices to absorb increased costs, it may attempt to estimate how much selling prices must be increased in the particular instance. This method has certain disadvantages. If the estimate is too low, it will be necessary to increase prices again in a short period of time, which will not be accepted too kindly by the customers. On the other hand, if the estimate is too high, the company may find that it is losing its competitive position.

A Cost Index and the Groupings to Be Established by It

There is one method available to the cost accountant which, while not as accurate as waiting for all increases to reflect themselves in product cost, provides a reasonably accurate method of anticipating the effect of various cost increases on total product cost. This method is one commonly referred to as a cost index. A cost index, as used by the cost accountant, is similar in nature to the cost of living index

BREAKDOWN OF MANUFACTURING COST FOR INDEX CONSTRUCTION

	Base %			
	1-1-56	2-1-56	3-1-56	Projected
Material	60	60.8	60.8	63.9
Labor	35	35.0	37.1	37.1
Miscellaneous	5	5.0	5.0	5.0
	100	100.8	102.9	106.0

EXHIBIT 1

computed by the United States Government. First, it is necessary to establish a date as the base period and consider all costs on this date as 100. All cost increases after this date will be expressed in relationship to the base. For example, a 2 per cent over-all increase in costs would raise the cost index to 102. Exhibit 1 is illustrative.

A cost index is only as good as the accuracy of the increases or decreases applied to the cost components that make it up. There are various sources for this information, such as trade journals, government statistical reports, etc. However, probably the most accurate source is the purchasing department, which receives earliest information of increases or decreases in prices. A cost index can be maintained either on an over-all plant basis or, if a plant manufactures diversified products, can be maintained for each product. Keeping a cost index by product necessitates more detail work and more adequate records. In either event it is necessary that cost accounting records be maintained.

Applying Changes to the Base Data

Let us assume that the following material cost increases became effective during January, 1957:

1. ABC Corporation, a supplier, announced a 12 per cent increase on bearings. As shown on Exhibit 2, bearing purchases from this company are 40 per cent of the total cost. This price increase would raise the ABC Corporation to 44.8 per cent as shown in the February 1 column (40 x 112).
2. Doe, Inc., announced a 13 per cent increase on bearings. This would increase Doe, Inc., from 30% to 33.9% as also shown (30 x 113).

These increases bring the bearing vendor percentage to 108.7 which, when applied to the bearing percentage in the middle section of the exhibit, would increase it to 38.0 (35 x 108.7). If we assume that unclassified purchased stores will tend to increase in the same ratio as total purchased stores, we must compute the increase of classified purchased stores and apply

DATA FOR MATERIAL COST INDEX

Breakdown of Material Cost

	Base %	Index		
	1-1-56	2-1-56	3-1-56	Projected
Steel	20	20.0	20.0	21.2
Steel Castings	15	15.0	15.0	16.1
Iron Castings	10	10.0	10.0	10.5
Purchased Stores	40	41.4	41.4	42.6
Motors	15	15.0	15.0	16.1
	100	101.4	101.4	106.5

Breakdown of Purchased Stores by Type of Material

	Base %	Index		
	1-1-56	2-1-56	3-1-56	Projected
Bronze Bushings	15	15.0	15.0	15.0
Bearings	35	38.0	38.0	39.3
Weld Rod	5	5.0	5.0	5.0
Cable	10	10.0	10.0	10.5
Lining	10	10.0	10.0	10.0
Chain	10	10.0	10.0	10.6
Sub-Total	85	88.0	88.0	90.4
Unclassified	15	15.5	15.5	16.0
	100	103.5	103.5	106.4

Breakdown of Bearings by Vendor

	Base %	Index		
	1-1-56	2-1-56	3-1-56	Projected
ABC Corporation	40	44.8	44.8	44.8
XYZ Corporation	20	20.0	20.0	22.4
Doe, Inc.	30	33.9	33.9	33.9
BCF Corporation	10	10.0	10.0	11.2
	100	108.7	108.7	112.3

EXHIBIT 2

this percentage to unclassified. In this case classified purchased stores increased 3.5 per cent (88 – 85 ÷ 85). This, applied to 15, gives us a new percentage on unclassified stores of 15.5. Applying the new purchased stores percentage of 103.5 to the purchased stores percentage of 40 in the top section of the exhibit, we get a new purchased stores percentage of 41.4 and a new material percentage of 101.4. If we then apply the new material cost percentage of 101.4 to the material percentage in Exhibit 1, it will

COST INDEX SUMMARY

Material

	1-1-56	3-1-56	Projected
Steel	20.0	20.0	21.2
Steel Castings	15.0	15.0	16.1
Iron Castings	10.0	10.0	10.5
Purchased Stores	40.0	41.4	42.6
Motors	15.0	15.0	16.1
	100.0	101.4	106.5

Labor

All Categories	100.0	106.0	106.0

Miscellaneous

All Categories	5.0	5.0	5.0

Company As A Whole

Weighting of all Elements	100.0	102.9	106.0

EXHIBIT 3

result in a new material percentage of 60.8. Adding the new material percentage to the labor and miscellaneous percentage, we get a new cost index February 1, 1957 of 100.8.

Now assume that, during February, that there were no price increases but a new labor contract was signed with an average increase of 12 cents per hour. If the average hourly rate was $2 per hour prior to the increase, the per cent of increase would be 6. This 6 per cent increase, applied to the labor percentage of 35 in Exhibit 1 gives a new labor percentage of 37.1 and a new cost index on March 1, 1957 of 102.9. Management can see from the cost index of March 1 that costs have increased 2.9 per cent since January.

Perhaps, in addition during February, the steel mills announced a price increase of 6 per cent across the board effective March 3. Because of the increase in steel prices and the wage pattern set by steel prior to the increase, various other vendors have announced price increases effective in the next thirty to ninety days. By analyzing

previously announced increases, the company can reasonably estimate the probable cost. To take another situation, the following material price increases were announced or anticipated in the near future:

1—Steel 6%
2—Steel castings 7%
3—Iron castings 5%
4—Remainder of bearing manufacturers 12%
5—Cable 5%
6—Chain 6%
7—Motors 7%

Using the same procedure as previously explained, these price increases are carried through the various accompanying schedules to the final figure of a projected cost index of 106.0.

Bridging the Gap Between Anticipated and Actual Increases

The cost index as reported to management as of March 1, 1957 would look similar to the one shown in Exhibit 3. With this information available, management knows that its cost has actually increased 2.9 per cent since the first of the year and that costs will increase approximately 6.0 per cent over the short-run period. Management now has an effective tool to determine by what percentage prices must be raised to absorb these increased production costs and can decide at what point it should make the increase effective to minimize the adverse effect on profits and customer relations. Even if prices cannot be increased, management has a reasonably accurate picture of what costs will be in the immediate future and can plan accordingly.

The cost index cannot, nor is it intended to, replace a good cost system. It is merely a tool to bridge the gap between actual and anticipated cost increases and their eventual reflection in manufacturing cost. The cost index is not an infallible means of determining cost increases. Hence it should be compared periodically with actual cost records to determine its accuracy. However, if adequate records are maintained, the cost index can serve as a very effective tool for management to chart its future course.

To establish the basis for a cost index requires that total cost be broken down into its logical components. As most companies apply a selling and administrative cost burden on a ratio to manufacturing cost, it is usually necessary to get a cost break-down only on the manufacturing cost level. The cost breakdown will, of course, vary considerably from one company to another, depending not only on the type of product the company manufactures but also on how detailed the company wants the breakdown to be. The simplest breakdown for constructing the index, and one which is adequate under most conditions, is to segregate total cost into three elements as follows (and as shown in Exhibit 1 which shows, as do Exhibits 2 and 3, infor-

mation relating to a hypothetical XYZ Corporation):

1. Labor—This element will include all labor cost to the manufacturing cost level and will include direct labor, indirect labor, and supervision and clerical expense. For determining the base percentage and any future increases, the over-all labor rate should be converted to a base rate per hour, excluding overtime premium. If the company has an incentive program, the premium pay should be eliminated in computing the base rates, because any fluctuations due to changes in incentive pay should not be reflected in the index. If the labor cost of any department, such as the maintenance department, is charged to other departments, this too should be eliminated in computing the base rate. Because these costs are not accounted for as labor, any increases will be reflected in other elements of cost.
2. Material—This element may include not only material used directly in production but also expendable supplies and repair items. Although expendable supplies and repair items might well be set out separately, in most companies they are a comparatively negligible factor and tend to fluctuate cost-wise in the same ratio as direct material. If any one material item is a large enough factor in total manufacturing cost so that its effect on cost and profits due to an increase would be immediately apparent, the item should be eliminated from the material factor so that it will not have a double impact on management decisions.
3. Miscellaneous—This element includes not only items normally considered as fixed charges, such as depreciation, taxes, etc., but also all other items which do not logically fit in the preceding two categories. This element is comparatively negligible in most companies and normally does not fluctuate with economic conditions to any great degree.

While, as mentioned before, these three categories are normally sufficient for the average company, an index structure is very flexible and can be easily adjusted to fit the needs of any business. If for instance, depreciation is an important factor in the manufacturing cost of any company, it can very easily be set out as a separate factor. In a company with adequate cost records, it should be possible to keep the miscellaneous factor at a maximum of 5 per cent to 10 per cent of total cost.

Information for a Material Cost Index

The material must be broken down into the various items which constitute total material cost. The percentage of each material component to total material cost as of the base period must be computed. The top section of Exhibit 2 is illustrative.

Each basic material component must also be broken down into its logical components as in the middle section of Exhibit 2. For instance, purchased stores will be broken down into its components such as bushings, bearings, weld rod, etc. In addition, each material component must be broken down by source. This is indicated in the bottom section of Exhibit 2. Although it is often difficult to get an exact breakdown of each component by vendor, it is frequently the case that vendors supply only one of the material components under consideration. If a particular vendor furnishes more than one component, an analysis of several weeks' invoices should be sufficient to arrive at a reasonably accurate percentage of distribution.

Having computed our basic information, we are ready to provide manage-

ment with a monthly cost index and are also able to project the effect of anticipated cost increases on over-all cost. Three illustrative examples make up the remainder of this article and make use of the information supplied in the exhibits for the hypothetical company.

The Necessity of Electronic Thinking

by B. E. WYNNE

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Current ceilings on effective data processing and communications in business will not be broken through, in the opinion of the present author, without penetrating thought applied to theory behind equipment now becoming available and to the company problems which its application is intended to resolve. A portion of this paper deals with the origin and stimulating potentials of the common language which computers employ.

MANY OF US take justifiable pride in recent accomplishments of improving efficiency and reducing costs of clerical routines. Many of us have installed machines which use the common language. These machine applications have made creditable savings and improvements for a reason which is quite elementary. We have used equipment which can inter-communicate through the punched paper tape, eliminating clerical labor in transcribing, and guaranteeing accurate repetition of data from step to step in our procedures. For the present, most will pursue further applications of these elementary machines. Their use will repay their cost many times, assuming that the machines are put to work properly, not merely substituted for manually impelled, key-driven equipment. These machines will be abused if they are used only as substitutes for manual devices. They challenge us to imaginative thinking and the creation of an entirely different viewpoint toward the accomplishment of clerical routines. They will force us to purge unnecessary information from our data processing routines and we will have to simplify and streamline our procedure.

I have definite ideas as to the level and character of the effort required. Perhaps there is no better way to communicate this and to introduce the sense of possibilities inherent in this area than to digress for a page or two to the common language idea, which is essential to the utilization of computers.

Common Language and Its Possibilities

Certain fundamentals make the common language possible. Informa-

tion must be reduced to basic form so that it may be manipulated by any of the equipment which uses the common language. And this basic form is the form to which data must be reduced for utilization even in an electronic computer. Punched cards, punched paper tape, magnetic tape, magnetic drums, cathode tubes, germanium diodes or transistors all join in the communications system through a common characteristic. The punched card or punched tape either does or does not have a hole at a predetermined position. The magnetic tape or drum either is or is not magnetized at each certain tiny position of its area. Each tube, diode, or transistor either does or does not bear an electrical charge. When the hole is present, when the spot is magnetized, or when the element is charged, we have a positive state which is called "pulse". The absence of the pulse is called "no pulse".

This, then, is the basis of the electronic machine's use of a language called the binary system. When the codes are written out, the pulse is represented by the figure "1" and the no-pulse is written by the figure "0". Our more familiar office equipment such as adding machines, comptomers, bookkeeping machines and cash registers have been founded on the familiar decimal system which uses the ten digits, 0 through 9; each additional counter position toward the left represents a successive power of 10. The binary system uses only the two digits 0 and 1, and each added position to the left represents a successive power of 2. This is to say that any series of digits, letters, punctuation marks, and even the spaces or other machine functions may be written schematically as a long chain of only two characters, either a "1" or a "0". Since the familiar teletype tape has five positions in each code, we can punch a hole or omit the punching at each of five points. Each small area then has two information possibilities. Our familiar figure, 2 raised to the fifth power equals 32, so that the five channel code can give us 32 different meanings. A six channel code would give us 64, and the eight channel code 256.

The teletypewriter automatically converts the figure "1" or the letter "A" as shown on the keyboard, into a combination of holes or no-holes (pulses and no-pulses), punched in the paper tape. In printing telegraphy, the circuit transmits a pulse or is idle for a moment in the absence of a pulse. It is obvious, then, that these electrical impulses could be received either to operate the printing mechanism of the receiving teletypewriter or to perforate a paper tape or both. It follows that the incoming message could be received in magnetic tape form or be placed in any other kind of memory unit such as a cathode tube or a bank of transistors. This is a simple alternate use of the five channel code which has been nominated

as the common language. But while we are accomplishing this communication, we could put the impulses through a "stunt box" which would translate the five channel code into any "native" language which might be required by specialized receiving machines.

The five channel code or any similar code is a series of pulses and no-pulses. Communication requires just as much time for a no-pulse as it does to transmit an actual pulse, and it is in this field that economies will be developed, reducing communication costs. Let us examine this prediction. When the telegraph was invented many years ago, Samuel Morse set up the familiar Morse Code. He assigned a short code to the frequently used letters such as "E" which is transmitted as a single dot. He assigned a long code to the infrequently used letters such as "V" which is represented by three dots and a dash. Morse used "horseback" statistics to develop his code, determining the relative frequency of use of letters by analyzing their rate of use in a print shop. From 1844 until shortly after World War II, there was no real improvement over the Morse Code.

Then mathematical statistics were applied to communications problems. Norbert Wiener of the Massachusetts of Technology is credited with discovering that the communication of information is largely a problem of statistics. His philosophical and mathematical Information Theory was translated into the workable terminology of the electrical engineer by Claude Shannon of Bell Laboratories. The Information Theory is also called the Communication Theory. It looks upon the binary digit as the unit of information, with each "bit" indicating the decision between two equally probable events. But, if codes are not well developed, there will be strings of zeros and strings of ones. If we tie up a communication circuit with this situation or with a great number of zeros and a small number of ones, or the reverse, we will waste circuit time and, therefore, waste money. Codes should be such that pulses and no-pulses appear in about the same amount. The standard five-channel common language code averages the use of about 47 pulses or no-pulses to transmit 10 random letters of the alphabet. We could rate its efficiency at 4. 7.

Although, the figures we use in business seem to appear at random, the sequence of letters in the English language is far from random. This has been proved by one of Claude Shannon's famous experiments in which he picks any passage from a book and records the number of guesses made by another person as to each successive letter in the sentences, one by one. On the average, only 330 guesses were required to state 100 letters in perfect sequence. One person who joined the experiment required less

than two guesses per letter. It is probably not feasible to attempt developing automatic coding and decoding as efficient as the human mind which has used the English language for years. The 4.7 efficiency of a five channel code is much poorer than the 3.3 average efficiency of the people who were the subject of Shannon's experiment of the 2.0 efficiency of his most successful subject. However, it seems possible that business machines may be able to treat letters in pairs, developing a better code.

If we go all the way from AA, AB, AC, to XZ, YZ ,and ZZ, we have 676 possibilities, 26 squared. But if we go to such a code, we may have a code for a single pair of letters averaging 9.4 pulses or no-pulses long. In spite of this, a statistical tabulation of the frequency in which specific pairs of letters actually appear in language would enable us to devise an entirely practical code. In the familiar five channel code not more than the first two of the five code positions are used for a pulse on the three characters of high frequency of use—the letter "A", the letter "E" and the functional impulse for "line feed." Similarly the frequently used letters "I", "S" and "U" do not require the transmission of a pulse beyond the third position in the five channel code.

If we should go to a code for pairs of letters, we could follow the same principle. Having statistically determined which pair of letters occurs most frequently, (TH or IE), we would give it a pulse code in the first position only. To the 676th pair of letters, the pair occurring least frequently, we would assign the longest code, 17 bits. With such a code it would take very little time to transmit those pairs of letters which occur with high frequency. We could well afford to spend more wire time for the rare transmission of those pairs of letters which occur with low frequency. The efficiency of such a code would be 3.56, a 25 per cent improvement over the 4.7 efficiency rating of a five channel code.

To make our suggestion clear, it might be well to amplify. If a code running from one to 17 spaces long were set up to cover the 676 possible pairs of letters, the average length of a code would not give the efficiency of 3.56 if we did not assign the shortest code to the most frequently used pair of letters. Blindly assigned, the average code length would be 9.4 bits. Since we contemplate transmitting a pair of letters in each code the number of bits used to express a single letter is ½ the 9.4, or 4.7—exactly the efficiency which applies to the Bidaut, our familiar five channel common language. The 25% efficiency improvement results from statistically applying the shortest code to the most frequently used pair of letters and so on down the line. This statistical application reduces the average code

length from 9.4 bits to 7.1 bits for a pair of letters and, therefore, to 3.56 for each single letter.

May I hasten to suggest that this 25 per cent gain in efficiency could not be developed overnight. The entire present basis of signal transmission on a telegraph circuit assigns six units of time to each character. Let us illustrate this. In the common language code, when all five tape positions are punched, we get the familiar "LETTERS" machine function. When this symbol is transmitted, there is a pulse on the circuit for each of five successive steps in time. At the end of the fifth step, the circuit rests and the system recognizes this as an equivalent to an end-of-character code. "LETTERS" is the only one of the present five-channel codes which uses circuit time fully. In proof of this, let us review whether the circuit is busy or loafing when the letter "E" is transmitted, remembering that six units of time constitute the transmission of one character. The letter "E" involves a pulse in only the first of the units. During each of the following four units no pulse is transmitted and then in the sixth unit of time the circuit is idle to indicate end-of-character. Would this not indicate that the five channel code really does not produce any efficiency through assigning the least number of pulses to characters used most frequently? As long as telegraph circuits are based on assigning a given length of time to the transmission of one complete character, the favorable assignment of codes to the most frequently used characters gives no benefit.

The Rigors of Electronic Thinking

We return now to "electronic thinking" which means the "de-bunking", the de-mystifying of clerical routines to the point that they may be accomplished by common language devices and electronic data processing machines. These machines can listen to or talk to each other. Some of them can do arithmetic and, through arithmetic process, perform logical choice and thereby make decisions. But they can listen only to machine language and their internal processes are rudimentary. Each problem is handled step by step. And men must furnish the program which the equipment is to follow in its lightning-fast manipulation of the data fed into it. Man must do their thinking for them in advance, and in the finest detail possible. It is because of this I have chosen the term, electronic thinking, for the rigorous mental discipline which we must learn to employ.

Each clerical routine must be examined critically, as to whether it is essential to the conduct of the business. If payroll work is under review, does each step have to be continued in order to write the pay-check, distribute costs, report data on tax withheld or fulfill some other absolute requirement? If not, it must be discontinued,

with one exception. Does it contribute to management control of the business? If so, perhaps it should be continued. Is this routine helping to build up a voluminous report which literally tells management that there is no decision to be made, that there is no action which needs to be taken, that everything is running as planned? If this is the purpose served, drop the routine. Management is too heavily burdened to be able to wade through a maze of data, only to learn that its time could have been better spent on another subject.

To go about data processing more comprehensively, we must recognize that clerical activities and duties are generally inter-departmental in nature. The true purpose of any one clerk's duties will reach outside the confines of his own bureau of division. The end-results of his work may be traced beyond. It follows that what he does and when and how he does it should be evaluated from the viewpoint of the higher organizational element which is served by his activities. This raises the question of who can exercise this viewpoint. In many offices the work-load is heavy enough to prevent the immediate supervisor from doing more than watching here and helping there, to ensure that today's work gets done today. He has little time to sit back and survey the how and the why of the situation. He usually has no chance to look at his own responsibilities objectively, testing the essentiality of his group's end-results and constructively criticizing his own methods, equipment and planning. And few if any of us have the ability to be utterly objective about our own activities. We can diagnose others quite well and sometimes too readily. But it usually takes someone else to examine us effectively.

A more comprehensive attack on data processing requires that a man or a group get up above the level of the present thinking. He must get the view from the press box, looking down somewhat remotely on a full team of eleven players and paying less attention to just how a back shifts his feet then to the more vital factors of timing and team-play. He must examine how one activity dovetails into many others. He must find which actions on the part of what men will make a more effective team out of the entire group. When a full-time analytical group has been placed in such organizational position that it can take this view of the company's activities, its function first is one of problem definition.

The group will know that the company's purpose is so to manage men, machines and money as to maximize profit to the community, the employees and the stockholders. So, the team will start tracing backward from the end-requirements through the long and interwoven chains of activity which make up the business. It will make detailed flow charts of present pro-

cedures and will write descriptive manuals to support the charts. It will run time analyses on the present people, machines and methods. Each area of activity will be expressed in terms of cost. And all this analyzing will be done in the degree of detail necessary to plan for the processing of data by electronic means. When the analyses have been completed, several areas of activity will stand out as being in need of correction. The finger will point for reasons of high volume, high cost, lateness of information or inadequate control.

At this stage in the survey, top management must be asked to decide the direction to be followed. The team will have completed its appraisal and its analysis. When the area to be attacked has been named by management, synthesis will begin. Now, of course, the team will have attended one or more schools for the training of programmers in electronic data processing and the company probably will have selected the manufacturer whose equipment is to be used. So the problem of synthesis is one of plotting the proposed electronic solution of accomplishing functions faster, more cheaply and with better information to management. Our electronics team will rough out a block diagram of the steps to be accomplished. Then it will make 'logical flow' diagrams which will give effect to both the interlocking nature of functions and the time sequence in which they occur.

The next step is to determine the point in the procedure at which the data should be put into the mechanized system. Since this is in code form, punched cards, punched tape or perhaps magnetic tape will be used. Then fully detailed programs will be written to instruct the computer just how to manipulate information. When these are completed, there will follow a test run on equipment provided by the manufacturer. A generous sample of actual data will be run against the programs, to prove that planning has been as meticulous as it must be for electronics to give proper answers. And modifications will be made as needed, so that when one's own "giant brain" is installed, he can put it to work without delay.

Keep the Broader View

It is certainly clear that companies exploit the use of machines which should read and write the common language tape even though these machines are far from the end of the road now open. As now developed, they preserve writing in mechanical form, eliminating transcription and its attendant inaccuracies. Some of them type, add, classify, summarize and perform rudimentary arithmetic. There is a distinct limit imposed by the very fact that we must go from one machine to the next, in order to accomplish the sequential steps through which data must be processed. This is just what we do today in punched-

card routines. More comprehensive systems of data processing require the use of electronic data processing machines where data flows through many processes without rehandling. What must we do to decide, under present conditions, whether we can afford not to have a computer; and how shall we begin to learn how to use it most effectively when it arrives?

First, we must find the men to carry the assignment. They should be familiar with the company and its policies. They must be free for full-time work without interference from other assignments. They must be imaginative, logical and objective in their thinking habits. They must have unusual memories, being able to assimilate an array of unrelated facts and then to assemble them into a pattern. Perhaps we are describing here the ideal systems engineer! Then, we must send these men to school so that they learn the language of the machines and the dumb, plodding, simple steps they take to process data. We must also study the market so as to choose the equipment for the use of which we are preparing. For our men must prepare themselves specifically for it.

Next, we must fully analyze our present procedures, setting them down both in flow-charts and in narrative form. We must also cost out each portion of the charts and prove the sum of these against our cost accounts. For, when we contemplate the use of truly electronic office equipment, we eventually will ask for a large appropriation which must be justified by definite economies overall. After this, our case must be presented to management. In addition to clerical economies, our proposed system will also improve management control and reduce our clerical requirements in the available labor market. Pointing out these considerations, we will attempt to aid management in its selection of the general objective of our initial attack. At this point, our group of specialists will begin to reconstruct our way of accomplishing clerical functions, eventually spelling them out for machine execution, then giving the plans an actual test on trial-run equipment. This last phase sounds much the hardest. It is the most technical but it is neither the most difficult nor the most expensive. Experience of several large companies indicates that the steps of appraisal and analysis take several times as long as those of synthesis and proof.

Now, through these several phases of our plan, our specialists have learned the disciplines of electronic thinking. Since they have analyzed procedures in terms of codes and machine functions, they have largely de-bunked many clerical routines once overrated as to essentiality, difficulty and method. They have spent several years, perhaps, and in this time their work has taken them into every section, bureau, division and department of the company. At last we have a staff group

which knows at first hand the inner workings of our company—who gets what data from whom, what he does with it and why. We have a group which has done much to show others how to simplify clerical routines. Then, when new equipment has been installed and its operation has become a success, we have a unit which will be able, each day, to draw information from a variety of sources, process it and feed it out where it is needed, all with greater speed, improved accuracy and lower cost.

This sounds like the millenium. It is not that, for it can be attained. In some companies it is now being attained. The day it is realized will be the day when your company has reached the true end of the road of common language development. Let us map the road:

1. Choose the right men and separate them from line responsibilities.
2. Educate the group in organization principles, work simplification, job analysis, Communication Theory, modern business machines and in electronic data processing. Have them attend university courses, study current literature and accept the aid offered by manufacturers of equipment.
3. Analyze present procedures thoroughly. Spend enough money to do it right by doing it in writing.
4. Apply common language machines wherever possible but not just by substitution for manual machines. Wring out of them their inherent savings possibilities by using them in a comprehensive system—not as small groups serving only at the bureau level.
5. Learn the fundamental differences between the various computers available today. Choose the one best suited to your particular type of problems.
6. Make your first application the one most likely of success. Be sure that it will reduce costs and will give more reliable management data at an earlier date.
7. Have ready a program for progressive expansion of a data processing center always ready to be more useful to management by relieving individual departments of the tedium of clerical functions.

There is a real organization-wide welcome for successful efforts in this direction. Essentially, we humans are strong in our individual preference. The sales manager succeeded to the job he has because he likes to sell. The purchasing agent is happiest when he is negotiating. The production manager likes to keep men happy and machines humming. Each of these men is only annoyed with the clerical demands thrust upon him. He would find welcome relief if there should develop a nerve center for the company, a data processing unit operated for the greatest benefit to all. The development of this nerve center is the accountant's challenge.

Common language development in a company must have a program. I have tried to suggest what that program should include. Even though it will lead to choice of equipment, merely acquiring this equipment is not our goal. Its use is only a better means toward our true objective—better management made possible through the use of data, stripped of redundancy, limited to that which is useful, reliably accurate and presented currently rather than historically, soon enough so that management can adjust to today's new situations before tomorrow night.

The Electronic Computer — Threat and Opportunity

By FRANK S. HOWELL

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In the past, at least, accounting has had to compromise with needs for flexibility, completeness, and accuracy because of the costliness of, or other impediment to, a more satisfactory accounting product. If this is substantially less necessary now with the potentials of electronic computers, where, asks the present author, will accountants (and accounting) stand if they continue to preoccupy themselves with the techniques of achieving these compromises and fail to reach out to new opportunities?

IN MILITARY language the term, "break-through", refers to a massive offensive action resulting in penentration into territory where the opposing side can offer no effective resistance. Often the breakthrough comes in a quiet sector which has been sadly neglected by its defenders, who awaken too late to the realization that they soon may be completely surrounded.

Industrial Accounting Built on Compromises with Detail

A comparable break-through situation threatens accounting today. Conventions and principles which have been accepted and taught as accounting gospel for years are being challenged by the electronic computer and are being found wanting. Engineers and statisticians are probing into areas heretofore concealed by such principles and conventions and are developing new lines of attack to which accountants must conform if they are to survive as members of a recognized profession. In the final analysis, many of our most cherished conventions represent nothing more than compromises with reality and, with the computer, there is little need for compromise.

The gospel truths of management accounting are particularly vulnerable to the attack which is developing. Industrial accounting systems are intended to meet the needs of management by indicating when and where there is need for action. It is accepted as logical that management needs should vary from one company to another, but the needs of management do not vary only from company to company. They vary from department to department within the company and from individual to individual within the department. Management is highly personalized. The type of data presentation which will move one manager to instant action may be dismissed by another as coming too late to be of value and may be laid aside for further study by a third.

This is, of course well-known, but rigidity of form in the presentation of

data has long been justifiable on the grounds that the necessary flexibility would be far too expensive and time-consuming. So there has developed the "grand compromise" of industrial accounting in which the typical company adopts cost accounting methods providing far too much information for some aspects of management, and nowhere near enough for others, and then attempts to train its management people to take effective action on the basis of data presented in the reports, all this in preference to shaping the reports to the needs of its individual managers. It is no wonder that the system purification preceding installation of a computer turns up so many "bootleg" forms and reports initiated by various individuals for their own needs. Many such reports can be dispensed with but, all too often, slavish adherence to principles and formats outmoded by the computer, itself, brings about a situation analogous to that created by using a ten-ton truck to deliver a spool of thread.

Even where management has successfully been trained to take needed action on the basis of pre-cast reports, the principles and conventions which have for so long governed construction of such reports represent no more than compromises between the cost of presenting complete information when and where it is needed and the value which might have been derived from such a presentation at some indefinite time in the past. Inventory valuation methods provide a typical example.

The concept of overhead, itself, is largely a compromise. Most overhead expenses could be analyzed in sufficient detail to assign them to some causative process or unit of production, but the cost of such an analysis, if made manually, would probably be far in excess of its value. All manner of methods have sprung up in connection with the allocation of overhead on a compromise basis, and the sanctity of these methods will be argued vociferously among accountants. However, the actual degree of accuracy in the end results of overhead allocation is apt to be of interest only to those unhappy management people who must employ a host of cost analysts to undo the damage wrought by the very reporting system which is supposed to guide management into action.

Only a Realistic Picture Will Do Now

The main reason for employing cost analysts, of course, is to ferret out the reasons for variations from previously established cost standards, as such variations appear in the conventionalized cost report. These analytical operations were complex enough when the dollars in which both standards and variations were expressed represented a more or less stable common denominator and when the end product and the production processes were firm factors in the equation. But today there is the additional factor of a continuing

decrease in the value of money itself. The complexion of the end product constantly changes and rarely will the last item coming off an assembly line be substantially unchanged from the first. Material prices may show violent fluctuations in practice, even when published prices appear to be relatively stable. As production processes become more automatic, training and engineering costs must be incurred, to be translated eventually into production costs. Consequently, any attempt at cost analysis on a historical basis under standardized reporting formats usually ends up with the analyst trying to explain a fantastic number of variances, without ever getting as far as answering the basic question of whether the costs so neatly crowded into the precast report form are in line with what they ought to be.

Electronic-Computer Implies Entirely New Possibilities

The capabilities of the electronic computer are seldom understood by those who would benefit most if it were properly employed. Far too often, it is used merely as a tool to expedite the processing of data into formats established under the need for compromise of one kind or another. The much-vaunted system purification so prominent in computer literature is seldom more than a lopping off of branches and off-shoots which were made necessary in the first place because needed management information could not otherwise be developed. From these and similar indications, it is clear that most accountants regard the computer as nothing more than a high-speed accounting machine. Most have failed to comprehend the tremendous significance of its ability to reduce almost instantaneously all aspects of business data, including dollars, numbers, words, punctuation marks and report formats to a common denominator consisting of only two elements in different combinations—on/off for the operating tubes and charge/no charge for the storage and reading.

The usefulness of the electronic computer as a means of detecting and reporting situations requiring management action is not restricted by any necessity for compromise over the question of cost. Once the basic data has been reduced to a charge/no charge storage condition, the cost of re-assembling such data realistically should be little if any greater than the cost of re-assembling it in accordance with a design conceived when the operating capabilities of the computer were undreamed of. Experience shows that the computer will, usually, produce an immediate dollar savings when it takes on a sufficiently large workload of repetitive operations. If it pays for itself in this manner, where, then, is the cost problem in obtaining information hitherto hopelessly hidden under the layers of compromise-inspired conventions which govern industrial

accounting? Is it not possible, within reasonable limits, to break away from many of the compromise concepts still being taught in schools of accounting and, in so doing, provide all echelons of management with the data required for their particular type of action? Certainly, it is, but the average accountant is simply not trained to visualize the changes which must take place if this is to be done.

Consider the common problem of budgeting in times of changing economic activity when demand for Product A may be increasing, while that for Product B remain stable, and demand for Product C declines. Nothing in accounting, as we know it, will furnish answers to the problems thus created, even with so few variables. However, application of analytical techniques well known to engineers and mathematicians provides a ready solution. The primary obstacle to the use of such techniques in the past has been the cost of working out the solutions, particularly when the number of variables is high. Accountants have not concerned themselves with the application of such techniques to the product of their labors, because it has been too expensive to work out the problems. Solving such problems on the electronic computer, however, poses few difficulties, either from the viewpoint of time required or from the viewpoint of cost. In all probability, the statistician who understands management needs and the management man who understands statistical analysis would need to know very little about conventional accounting to effect a vast improvement in reporting methods—if they understood the computer.

The Future Depends on Grasp of New Concepts

It is daily becoming more apparent that, from the break-through of the almost forgotten line of accounting compromise, a new profession must emerge. Accountants, if they will expand their horizons by firmly grasping the strengths and weaknesses of fundamental analytical technique and by grasping equally as firmly the principiples of computer logic and operations, can become the dominant factors in this profession, provided only that they possess sufficient imagination to construct from the characteristic charge/no charge building blocks of the computer more effective and more realistic reporting techniques. However, if they fight valiantly for continuance of concepts of compromise which have no validity under the computer, if, in effect, they continue to look upon the computer as nothing more than a glorified accounting machine, they can, in the not too distant future, expect to find themselves in a position where their services are no longer of much value to management.

From Punched Cards to Computer — A Voice of Experience

by JACK W. SCHREY

Assistant General Comptroller, The Magnavox Company, Fort Wayne, Indiana

The maintaining at minimum cost of balanced inventories of thousands of parts subject to rapid obsolescence in many cases, a situation characteristic of the radio and television industry (and others) sparked the desire of this company to go from punched cards to computing equipment. Preparation for the change and the change itself, are briefly described in this article, with note of extension of use of the equipment to payrolls and to servicing of engineering department needs.

THE INSTALLATION of computers, small, medium and large scale, seems to be a fashion in today's business. Because of this, the application of lessons of experience in the installation of computers and in the decisions surrounding the investing of company funds and possible adaptations of the equipment tend to get lost in the shuffle of staying in style. Actual experience with such an installation and such decisions indicates to me that the following are basic and fundamental considerations:

1. Organizational structure of the company —multi-plant vs. single operation.
2. Current applications of punch card accounting, taking into consideration that some computers lend themselves well for utilization of current punch card systems, whereas others require basic changes in technique and application.
3. Solution to problems in which the current systems are deficient, problems which possibly may be solved only by the use of a computer.
4. The personnel available and the investment of such personnel in the computer operation.
5. The program for the installation of the computer, if such seems to be desirable.
6. The education of all operating departments of the business as to the peculiarities and potential of the computer.

Most of these considerations will appear in the present case narrative, at appropriate points. Our general offices are located in Fort Wayne, Indiana where all engineering and centralized purchasing are conducted. This lends itself well in conversion to a centralized data processing operation. We have manufacturing plants at Greeneville, Tennessee; Jefferson City, Tennessee; Evanston, Illinois, and Paducah, Kentucky. We have tabulating installations for local problems at both our Greeneville and Paducah plants. The current applications of punch card accounting within the company include the following:

1. Payroll and allied labor reports.
2. Material control both as to inventory and purchase requirements.
3. Production reporting.
4. Finished goods inventory control.
5. Accounts payable.
6. Invoicing.
7. Customer order processing, including packing slip preparation for shipping.
8. Sales analysis.
9. Cost of sales.
10. Expense ledger including budget comparison.
11. Other miscellaneous reports.

The Problem; Equipment Selection and Program of Installation

We found some two years ago, in analysis of our current methods, that the speed of the processing equipment, which was of a punch card nature, was too slow to present certain data needed in the maintaining of balanced inventories as our business expanded. Further, we were faced with the problem of maintaining accounting record costs at a minimum. The inventory requirement was most significant to us, primarily by reason of the fact that model changes are inherent within the TV industry. These enginering changes are constant and, to maintain our position within such an industry, we must retain extreme flexibility as to production. Our firm's product line includes a wide range of models and finishes, each model custom-designed, not merely re-dressed and given a new name. Less than half of the parts are common to two or more models. We have no distributors—consequently, we must remain extremely close to the customers' whims and desires.

The result is a type of production activity which demands knowledge of current status of all productive components and assemblies. Our punch card equipment furnished this information on a semimonthly and monthly basis. This was not adequate to make the day-to-day decisions required. After a large number of conferences at management level, it appeared that a high speed computer, which retained somewhat the same approach as our existing methods would be desirable. This decision made, we selected a particular type based on the following facts:

1. The IBM 650 computer appeared to be an extension of existing method concepts, only faster, requiring little change in basic documents or philosophy.
2. It did not require change in recoding of machine language used in present files of parts and models.
3. Equipment for the auxiliary work, such as punching, sorting and printing, was already available.
4. Branch operation recording could be used without translation.
5. Being compatible with present equipment, the 650 permitted us to think in terms of immediate discontinuance of present equipment.
6. The manufacturer had an established record of equipment reliability within our company and we were confident we could count on a great deal of assistance from him, in both the installation and programming of the equipment and in the "debugging" as well.

Our equipment having been selected, it was then necessary to provide a program for installation. This included:

1. Personnel Selection—Assigned two men exclusively to 650 programming. Each of these men had previous experience in company accounting problems, were familiar with inter-department procedures, had a working knowledge of present punch card equipment and were able to devote full time to the problem.
2. Program—The assignment of these men, made approximately 14 months in advance of estimated receipt of the computer, was as follows:
   a. They were to learn the computer operation techniques.
   b. They were to present, in flow chart form, present procedures for the primary application material control).
   c. They were to prepare programs in computer language.
   d. They were to plan and order card and reports forms.
   e. They were to plan and order accessory equipments, which includes files, trays, etc.

f. They were to train machine operators and department personnel.

g. They were to actually install and operate the equipment during the "debugging" process.

This program was presented to management in schedule form as to estimated dates required to meet installation date.

Parts Record Application

In the process of the programming looking towards presentation to management of quantity records for the 15,000 parts which are currently utilized within our production, machine tests using company data proved that we could think and plan towards the practical maintenance of these inventory balances daily. This required using the computer at night and utilizing transceivers which provide card-to-card information from a remote location, in this case, our Greeneville plant. The flow of the information and the rapid processing by the computer would provide local management information on which day-to-day scheduling could be provided. In comparing the processing of the data from the computer test, we found that not only time but cost and accuracy were heavily in favor of the computer. The following chart is indicative:

	Computer	Tabulating
Processing time	58 min.	18 hours
Number times card handled	1	18
Number separate processes	1	9
% Time operator occupied	5%	40%
Established machine and labor cost	$26.00	$37.50
Supplies used	$ 2.00	$12.00

We further found, in programming procedural changes to gain better utilization of the peculiar ability of the computer, that certain types of the action originally planned as a manual operations could be mechanized. For instance, we found that a material requisition could be prepared accurately from computer information. Another example is our mechanization on a daily basis of the production count of sub-assemblies in time to provide the information required by the computer. This resulted in the elimination of a large, uneconomical five-section form and the substitution therefor of a smaller, less expensive form which permitted machine counting, eliminating one employee and saving over $6,000 per year in forms cost.

Payroll Application

The second application which we had originally in our mind was one for which the transition from punch card operation to computer is relatively simple. This is, of course, factory payroll. We are currently preparing payroll in card form which requires only the printing at the local level, with processing on a centralized basis, in approximately one twentieth of the time previously required. This application had practically no problems, since there were no inter-department organizational lines to cross. The original source of the information was not changed, and the resulting reports, such as the payroll register, checks,

labor analyses, etc. were identical with those prepared under the previous system. We did take advantage, however, of printing the checks in tabulating card form which provided bank reconciliations on electronic equipment. The payroll installation required "running-in-parallel" only for one week.

The Progress of the Applications; Looking Ahead

The payroll application is running smoothly and economically. We move from a punched card representing hourly attendance to payroll check and updated year-to-date pay information, with 300 computer instructions. This yields a significant saving in time and money as compared to punch-card processing. Our first application which was to material control, was made with some difficulty, principally because it was necessary to educate all departments at a time when their energies were absorbed by the high volume level at which our business is currently operating. Aversion to change is not unusual and calls for no reproach. However, it presents a peculiar problem to any revolutionary step and process, such as the installation of a computer. It is necessary for the missionaries of such a program to continually make enthusiastic converts of members of the management team. They must be convinced that the computer has definite benefits to them in their day-to-day problems.

We have only scratched the surface in respect of the material control functions. For instance, we currently prepare purchase requisitions on the computor; with relatively slight innovations in procedures, we foresee that the actual purchase orders could be prepared. A complete mechanization of the source data for the computer seems possible. This includes not only the mechanized production reporting and accounting, mentioned above, but also control of engineering changes, substitutions, receiving reports, etc. This can be done by mark-sensing equipment, typewriter key punch, or prepunched cards. Our experience in the proper utilization of the computer to solve business problems indicates to us that we are not far away from, in effect, handing the original order to build to the computer and, from its unique ability and that of the associated electronic data processing equipment, being able to produce the necessary paper work to provide the applicable part to the stockroom without further manual clerical effort. The potentials of the computer for marketing study are likewise apparent. Thus, management may more adequately review trends in models and customers' desires, and thus make more realistic decisions.

Utilization of the Equipment by Engineers and Others

At the present time, the engineering department is utilizing the computer to an ever-increasing extent. We ap-

proached this problem by educating, together with accounting staff, an engineer who is responsible for the application of the computer to the solving of mathematical formulas. The engineering department is increasingly demanding more time. We insist that the engineers do their own programming rather than have us program the problem for them. We feel that an engineer with knowledge as to the potential of the computer can more easily program his problem than tell us what he wants and have us program it for him.

There is a definite need to emphasize the real value which the computer has to officers of the company. Not only can these officers obtain answers to some questions they have not raised in the past, due to the clerical task of compiling and summarizing figures, but they now have a tool through which, with intelligent application, they may get answers in time to take adequate corrective measures. We feel that, in the future, officers are not going to have to sit back and wait for the results of their work to come "off the press" but, rather will immediately receive notice of deviation from the courses charted and will alter these courses before damage is done.

Processing Our Pay Roll On the IBM 650

by MATTHEW E. STIRLING

Assistant Controller, John A. Roebling's Sons Corporation, Subsidiary of the Colorado Fuel and Iron Corporation, Trenton, New Jersey

Brief indications of "spade work" which preceded computer selection are given in this case study with greater attention accorded preparation for the installation itself and the conduct of programming against particulars of the payrolls involved. Pre-operation testing is also dealt with. The company is still in process of extending its payroll applications of the computer.

HOW OUR COMPANY installed and is computing payroll on an IBM 650 magnetic drum data processing machine is described in this article. Roebling personnel consists of 4500 employees of which 3100 are paid on an hourly or incentive basis. The remaining employees are salaried. The company manufactures wire products. It has four manufacturing plants, one located at Roebling, New Jersey and the other three at Trenton, twelve miles away. The Trenton plants are situated approximately one mile from each other. The administrative and sales offices are also located at Trenton. Within the plants there are six manufacturing divisions; the open hearth and hot mills, steel wire mills, electrical wire, wire rope, cold rolled products, and bridge. Payroll records are collected and controlled by payroll preparation clerks located in the respective divisions and forwarded for processing by inter-plant mail service to the payroll-tabulating departments in the administrative and sales building. All hourly employees and more than half the salaried employees are paid weekly by check.

The first step in making a decision as to whether or not electronic data processing would benefit the company was a feasibility study made by a committee headed by the controller. At the time of the study, the company had in operation a partly mechanized payroll procedure under which all day work operations, incidental allowances, weekly salaries, gross to net earnings, and various payroll statistical reports were computed on an IBM calculator. In addition, checks were written and employees earnings records were processed on tabulating equipment. Incentive payroll, however, was prepared manually and mark-sensed for mechanical processing. It was in this field of incentive payroll that the committee discovered savings could be obtained.

Training the Programming Staff

Preliminary Survey

Immediately thereafter a payroll programming staff was organized, consisting of the manager of tabulating,

the assistant manager of payroll and timekeeping, a cost engineer and a payroll auditor. The functions of this staff were to be coordinated by the assistant controller. Each member was carefully selected because of his past experience in handling functions of payroll, cost, and tabulating. Although the venture was an entirely new one, it was felt with confidence that each member of the staff had the ability to readily acquire the technical skills of programming for the equipment. Two members of the staff, the manager of tabulating, and the assistant manager of payroll and timekeeping attended the basic training sessions and later the advanced programming school, conducted by the manufacturer to learn the techniques of programming and coding. The two remaining members of the staff received their training from the others. It was learned that programming is the art of analysing and planning the various routines required to obtain, through internal calculator computation, a complete, accurate, automatic, economical, and uninterrupted processing of all conditions existing in input data. Coding is the art of translating the program into numerically coded instructions which, when fed into the computer, act internally as a stored program of computer procedure.

Having completed their training, the members of the staff were in a position to formulate plans for actual programming. They had one objective —to prepare in the shortest possible time the minimum number of programs which would give, in both a timely and an economical manner, all payroll reports as required. The plan was:

1. To make an educational survey of the various wage payment plans and their administration.
2. To concentrate programming, at the outset, on incentive payroll, preparing at least one program that could be taken to the IBM test center.
3. To convert programs currently in existence on conventional tabulating equipment to programs for the new equipment.

Study of Existing Pay Roll Source Records

Having dealt with these problems, the planning staff gave next consideration to source records. At this point, the analysis shifted to the study of existing payroll records with an eye to possible consolidation for the purpose of obtaining the best program. Our payroll source records consist of four reports, i.e., an attendance card, a force and time report, a production record, and an authorization for nonstandard payment. Study of these records revealed such information as to what was done, how it was done, where it was done, when it was done, and by whom it was done.

The attendance card is a weekly clock card upon which the employee registers his daily starting and finishing times. This card is manually extended by the payroll clerk for the total hours worked and the overtime premium hours to be paid. The shift

differential amount is also calculated and inserted on the attendance card.

The force and time report is a shift record prepared by the plant foreman, giving a complete distribution of time, by occupation, for each employee. An occupational code is part of this record. The record was an outgrowth of earlier partial mechanization of payroll and was developed with two intentions, the standardization of a plant-wide method of reporting time worked by the employee, and to provide a one-type simplified record for key-punching the time record for mechanical processing. It required occupational codes, also required for processing payroll by the IBM 650. The code consists of five digits and identifies the type of payment plan, the occupation, and the incidental operations inherent in the occupation. From this occupational code the following can readily be determined:

1. Occupation.
2. Rate of payment for day work hours, general increase adjustments not included in incentive base rates (add-in amounts) and maintenance of earnings adjustment amounts in respect to incentive plans.
3. Classification of labor
   a. Type of payment plan.
   b. Occupation.
   c. Cost distribution account.
4. The relation of incentive earnings to incentive hours.

The production record is a complete history of production. Many variations are introduced in these records because of the diversification of product, operation or method of pay. The production record may be for an individual or a group of employees. The association of production to hours worked is made through the use of the employee identification number and occupational code. In some cases, production records had to be revised and occasionally identification codes had to be developed in order to adapt them to the new process.

The authorization for non-standard payment is the payroll department's written authorization to deviate from standard practice.

Finally analysis of the output records was made. Each was reviewed for possible elimination, simplification or combination with another record. Upon completion of the analysis, it was decided that the attendance cards, force and time reports, occupational codes and authorization for non standard payment could be used without modification for programming the new equipment. However, dissimilarity in the incentive schedules, reflected in both the source record and the output record, confined payroll programming to a manufacturing operation, such as steel making, hot rolling, wire drawing, etc.

Programming the First Application

The first application selected for programming was the hot rolling operation, since this operation was typical of the many problems. The staff group proceeded to the programming task. Two large type classroom

blackboards were used for group planning and discussion before program steps were committed to paper.

The group first sought to define the problem, i.e., to examine the requirements of preparation of this payroll. Hot rolling is a line operation comprised of 22 occupations, with one employee or more per occupational position. Input data is quite formidable. Incentive payment is on the standard hour plan. Application incentive rates (time-values) vary with the occupation. In addition to incentive rates for productive operations, the plan provides incentive rates for a series of non-productive incidental operation. The standard hourly wage rate is applicable to standard hours earned and, likewise, to hours of "off-standard" condition. Each occupation has its standard hourly wage rate with some occupations having a maintenance of earnings adjustment applicable to all hours worked. The plan provides for a guarantee of wages to the employee per occupation for hours worked per shift at the standard hourly wage rate when the department index of performance is below 95 per cent or for hours worked at the standard hourly wage rate plus the maintenance of earnings adjustment, where applicable, when the departmental index of performances is 95 per cent or greater. In addition to the foregoing, there are payment stipulations that certain activities on the part of the employee must be considered "outside" of the incentive plan and paid for at the standard hourly wage rate of the occupation only.

Output record requirements for this payroll to the point of gross earnings consist of a report per shift indicating quantities produced, incidental operations performed, a break-down of hours worked, standard hours earned, an index of performance per employee, and a departmental index for mill employees. A report duplicating the information provided for the mill employees but, in addition, to include make-up earnings (difference between actual earnings and guarantee earnings) and total earnings per employee is required for the payroll department and a distribution of labor dollars by accounting codes for the cost department.

After examination of input and output requirements, it was necessary to confront the problem of fitting them to the IBM 650 magnetic drum data processing machine. The magnetic drum consists of 20,000 positions of numeric storage which are divided into 2,000 ten-digit "words", Each "word" is assigned a specific store-number location from 0000 to 1999 for machine identification. The problem must be adapted to these machine limitations. Due to the nature of this problem all earnings must be stored on the drum, together with the employees' identification numbers, occupation codes, rates and the cost distribution accounts. All of this infor-

STORAGE LOCATIONS ON IBM 650 MAGNETIC DRUM (HOT ROLLING MILL PAYROLL A)

	Instructions	Employee-Data	Occupation Codes	SHWR	SHWR/ MEAR	
Drum Locations	0000 - 0599	0600 - 1199	1200 - 1229	1230 1259	1260 - 1289	
	Accounting Distribution			Incentive Rate Tables		
	Rounds	Flats	Misc. D. W.	Rounds	Flats	Roll Change
Drum Locations	1290 - 1319	1320 - 1349	1350 - 1399	1400 - 1549	1550 - 1699	1700 - 1849
	Read Storage Entry	Punch Storage Output		Explanation of Abbreviations		
				SHWR	Standard Hourly Wage Rate	
Drum Locations	1901 - 1910	1927 - 1936		MEAR	Maintenance of Earnings Adjustment Rate	
				Misc. DW	Miscellaneous Day Work	

EXHIBIT 1

mation had to be assigned to specific locations on the magnetic drum as illustrated in Exhibit 1. In addition, provisions had to be made for storage of instructions to be developed in the programming.

The block diagram is a graphic flow chart which indicates, step by step, the procedural flow of the work through the machine. The procedure is outlined similar to the manual method employed and consists of making the same decisions, same calculations, and obtaining the same results. The diagram is used by the programmer as an outline for writing machine instructions. It assists, in keeping the over-all requirements of the problem well in mind and it reduces a large problem that may be difficult to visualize and comprehend into a series of small problems, each of which may readily be visualized and understood. Such a diagram is illustrated by Exhibit 2 which relates to instructions for gross to net payroll. (Those for gross pay are not susceptible of reproduction here.)

Coding of instructions followed. In this step the block diagram was translated into coded machine instructions which would be stored on the drum and used to direct the solution of the problem. These coded machine instructions perform standard machine operations such as selecting, adding, multiplying, dividing, storing, and producing results which satisfy the various routines of the program.

The first program was completed in ten days. Four hundred and eighty instructions were written and 551 "words" were used for table storage of occupational codes, rates, and distribution accounts. Two input cards were required, one for time and the other for production, and the end yield was two output cards, an employee occupational summary card and a cost accounting distribution card. The completed program was compiled in a manual and forwarded to the

BLOCK DIAGRAM OF COMPUTER PROGRAM FOR GROSS TO NET PAYROLL

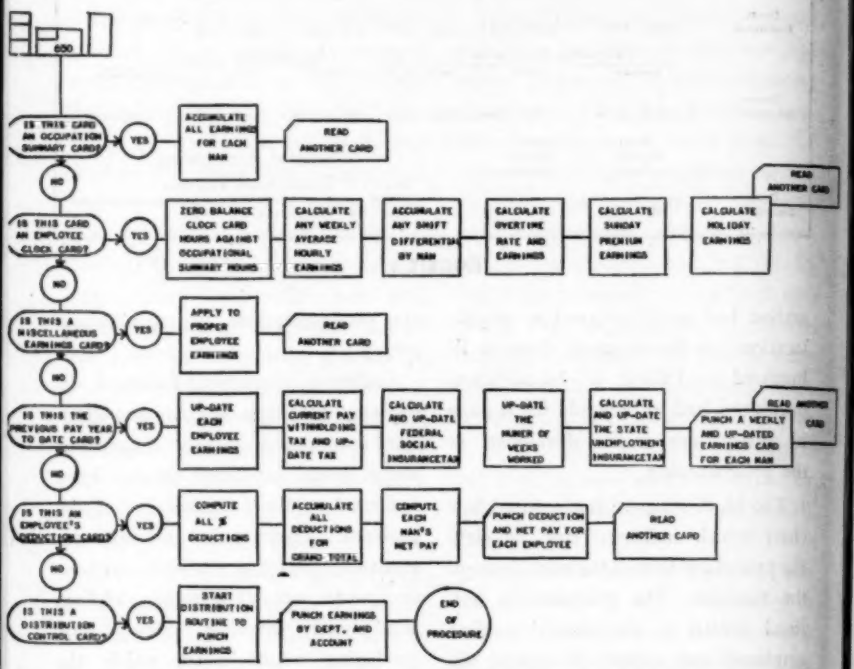
650
IS THIS CARD AN OCCUPATION SUMMARY CARD?
YES
ACCUMULATE ALL EARNINGS FOR EACH MAN
READ ANOTHER CARD
NO
IS THIS CARD AN EMPLOYEE CLOCK CARD?
YES
ZERO BALANCE CLOCK CARD HOURS AGAINST OCCUPATIONAL SUMMARY HOURS
CALCULATE ANY WEEKLY AVERAGE HOURLY EARNINGS
ACCUMULATE ANY SHIFT DIFFERENTIAL BY MAN
CALCULATE OVERTIME RATE AND EARNINGS
CALCULATE SUNDAY PREMIUM EARNINGS
CALCULATE HOLIDAY EARNINGS
READ ANOTHER CARD
NO
IS THIS A MISCELLANEOUS EARNINGS CARD?
YES
APPLY TO PROPER EMPLOYEE EARNINGS
READ ANOTHER CARD
NO
IS THIS THE PREVIOUS PAY YEAR TO DATE CARD?
YES
UP-DATE EACH EMPLOYEE EARNINGS
CALCULATE CURRENT PAY WITHHOLDING TAX AND UP-DATE TAX
CALCULATE AND UP-DATE FEDERAL SOCIAL INSURANCE TAX
UP-DATE THE NUMBER OF WEEKS WORKED
CALCULATE AND UP-DATE THE STATE UNEMPLOYMENT INSURANCE TAX
PUNCH A WEEKLY AND UP-DATED EARNINGS CARD FOR EACH MAN
READ ANOTHER CARD
NO
IS THIS AN EMPLOYEE'S DEDUCTION CARD?
YES
COMPUTE ALL % DEDUCTIONS
ACCUMULATE ALL DEDUCTIONS FOR GRAND TOTAL
COMPUTE EACH MAN'S NET PAY
PUNCH DEDUCTION AND NET PAY FOR EACH EMPLOYEE
READ ANOTHER CARD
NO
IS THIS A DISTRIBUTION CONTROL CARD?
YES
START DISTRIBUTION ROUTINE TO PUNCH EARNINGS
PUNCH EARNINGS BY DEPT. AND ACCOUNT
END OF PROCEDURE

EXHIBIT 2

tabulating department for the purpose of preparing a wiring diagram, a machine loading routine, and for key-punching machine instructions and tables. After the key-punching of the machine instructions and tables, the program was listed in "drum-words sequence" on a tabulator. From this listing, a test was performed by the programmers who manually processed test samples using the coded machine instructions covering each step as shown on the block diagram. The manual test was made to eliminate, as much as possible before machine-testing, errors made in coding, storage, and instruction writing.

After being satisfied with the manual testing of hot rolling mills department gross earnings, we programmed gross to net earnings to complete a cycle of payroll preparation from source record to check writing. The same procedure that was used to de-

velop the hot rolling program was used for all succeeding programs. On the gross to net programming, because employees are subject to transfer from one occupation or manufacturing operation to another, it became necessary to summarize the employee's earnings obtained from the various programs for the pay period. The summarization of employee earnings became the basis for the gross to net program. The block diagram of computer program for gross to net payroll, already cited as Exhibit 2, illustrates the numerous routines necessary to process the occupational summaries obtained from source to gross program to the final output necessary for writing payroll checks and registers. It is to be observed that the hours recorded on the production and force and time reports are verified with the time recorded by the employee on his attendance record.

All premium pays, including overtime, holidays and Sundays are computed. Federal, state and city taxes are calculated, taking into consideration taxable limits where they exist. Deductions are accumulated and the net pay for each employee is computed. Output cards contain all pertinent data for the employee's weekly earnings and deduction records. Earnings and taxes are up-dated for the year for each employee. From these earnings and deduction output cards, the payroll registers and tabulating card checks are prepared on the tabulating printing machines. Output cards for premium earnings computed in the gross to net program are punched to complete the accounting distribution phase of the program. These distribution output cards are combined with the cost distribution output cards of the source to gross earning programs for a complete cost accounting distribution of all payroll earnings for the period.

Installation, Testing and Operation of the Computer

It is the practice of IBM not to release a 650 magnetic drum data processing machine until satisfied that the customer is in a position to put the equipment to actual use. For this reason, two days were allowed us to test the hot rolling mill gross payroll, gross to net for all hourly payroll employees and several other programs at the test center in Endicott, New York. The tests were made by processing selected samples taken from payroll records covering all routines programmed. The testing proved very successful. It was found that 1400 instructions were proved before discovering an error. This, we were told was better than average success. Prior to the arrival of the equipment at our company an area of 225 square feet was enclosed adjacent to the tabulating department for location of the machine. This area was equipped with two five-ton units of air conditioning and a humidity control unit.

Payroll programming was continued and, by the time the computer was delivered, an additional number of pro-

grams were completed. Two members of the programming staff were immediately assigned to the machine operations of testing and installing completed programs. During the initial testing period, the machine was demonstrated to all plant foremen, as part of the company's established training program. Its functions, requirements and effects, with special emphasis on payroll processing, were carefully explained. It is still the case that, before each installation of payroll on the machine, meetings are held with the respective foremen, payroll and tabulating personnel for a complete review and explanation of the payroll record requirements. A parallel system of old and new procedures is maintained for one or more weeks to ascertan that no condition of input has been overlooked when developing the program, and that the time and production records are being properly prepared for processing by machine. The program is then released as a payroll-tabulating function.

All installations of payroll on the IBM 650 magnetic drum data processing machine have been made with complete satisfaction. A continuous payroll audit is maintained of all records computed on the machine. This audit is quite extensive at the beginning of each installation but, in a short period, is reduced to a process of spot-checking. Although a few errors have been discovered, none can be attributed to the machine. The conversion of payroll from manual to electronic processing has offered no serious personnel problem. Although it is true that the conversion decreases considerably the need of payroll calculating clerks, it has been found that the normal turn-over of personnel within the payroll department and other departments through out the company, to which displaced payroll clerks are transferred, has provided an excellent release.

To date, the programming staff has written 20 programs. Currently the company is processing, in addition to the hot rolling division gross payroll, the gross to net payroll for all hourly employees, the weekly salaries, accounting distribution, and a series of incentive programs. Indications are that the completed installation will result in a savings in payroll personnel cost which will more than offset the rental of the equipment. Further savings are anticipated with the application of the equipment to production planning and control, engineering, and other routines.

Processing Our Pay Roll On the Univac

by T. E. AIKEN

General Procedure Supervisor, National Tube Division, United States Steel Corp., Pittsburgh, Penna.

Centered about organizational preparation for and accomplishment of programming for an electronic computer payroll application, the present paper also deals with selection of equipment and preliminary planning for the installation. The author also notes, among other, general considerations, the counter-current to decentralization which the use of electronic data processing represents.

OUR ORGANIZATION has six works, located in Gary, Indiana, Ellwood City, Pa., Lorain, Ohio, Fairless Hills, Pa., and two in McKeesport, Pa. All of these are included in our present plans for computer application, except Fairless Hills. Altogether we have about 22,000 wage employees. Our company had previously attained a high degree of mechanization of volume clerical functions on punched card equipment, which provided a good foundation when we began considering the utilization of a large-scale computer in these areas.

In the fall of 1953, surveys were carried out at two of our works to determine the feasibility of using either a medium-sized computer or a large-scale computer to perform clerical functions of large volume. As a result of these surveys, which lasted several months, a decision was made to obtain a large-scale computer. Accordingly, an order was placed for a UNIVAC, which is a large-scale general purpose digital computer, including a fast method of converting data from punched cards to magnetic tape, and a high speed printing unit. Inasmuch as our plants were already set up to produce punched cards as the first step in most of the accounting processes, we tied into the system at this point with a card-to-tape converter which transcribes 80-column tabulating cards onto magnetic tape at the rate of 240 cards per minute. The Converter is composed of three units—a card reading unit, a tape recording unit, and a verification unit which rereads both the card and the tape and compares the two. The speed and capacity of the computer is so great that a high-speed printer is necessary for printing out the results.

Preparing for the Installation

From the feasibility studies, we had reached the decision to apply the computer first to the processing of our payroll. There were two main reasons for our selection of payroll as our first computer application. First, the payroll system was already highly mechan-

FORM LAS-101

B WORKS CODE	10-17-54 WEEK STARTING DATE	NATIONAL TUBE DIVISION	EMPLOYEE WORK SCHEDULE

OCCUPATION TITLE / EMPLOYEE NAME	CLOCK NO.	OCCUP. GRP	OCCUP. NO.	JOB CLASS	INC. CODE	WC & E CODE	DIST.	INCURRED RESP.	INCURRED OP	FOREMAN GROUP	MAIN LINE NUMBER	SUB LINE NUMBER	TURN 1 SUN	MON	TUE	WED	THU	FRI
NORMALIZER HEATER		7	700	12	012	1100	3	207	00	06	01		1	2	3	4	5	6
W HART	1012						3					01	1	2	3	4	5	6
													8	8	8			8
STAMPER		7	704	03	012	1100	3	207	00	06	03		1	2	3	4	5	6
~~G HAUK~~	~~1015~~						~~3~~					~~02~~	1	2	3	4	5	6
M LUDA	1017						3					02	1	2	3	4	5	6
													8	8			8	8
F KRIEGISH	4236												1	2	3	4	5	6
															8	8		
													1	2	3	4	5	6

EXHIBIT 1

ized on punched card equipment, and thus lent itself readily to conversion. Second, the payroll function offered a substantial area for cost and efficiency improvement. At the time the orders were placed for the equipment, procedure personnel who were to direct the activity began the job of re-designing our payroll procedure for processing on the computer. Several months were spent in developing flow charts, outlining the system, defining the functions to be performed in each computer run, and determining that all report requirements would be met.

The function called programming is probably the largest part of the preparation for a computer application. A general purpose computer can perform almost any conceivable type of computation or data processing operation but, to do so, it must have detailed instructions as to every step. The preparation of these instructions is a highly technical task and so time-consuming that, for a major application such as our payroll, it must be measured in man-years of effort. As soon as our equipment was ordered, eleven procedure men from our works and general office were selected for training in this new field. These men were given a twelve-week programming course by the computer manufacturer. Eventually six more programmers were added and put through a similar training course.

When the first group of programmers completed their training, they began at once the task of converting the procedures to computer instructions. By the time that installation of our computer had been completed, six months later, the programming for the gross-to-net portion of the payroll was finished and ready for testing.

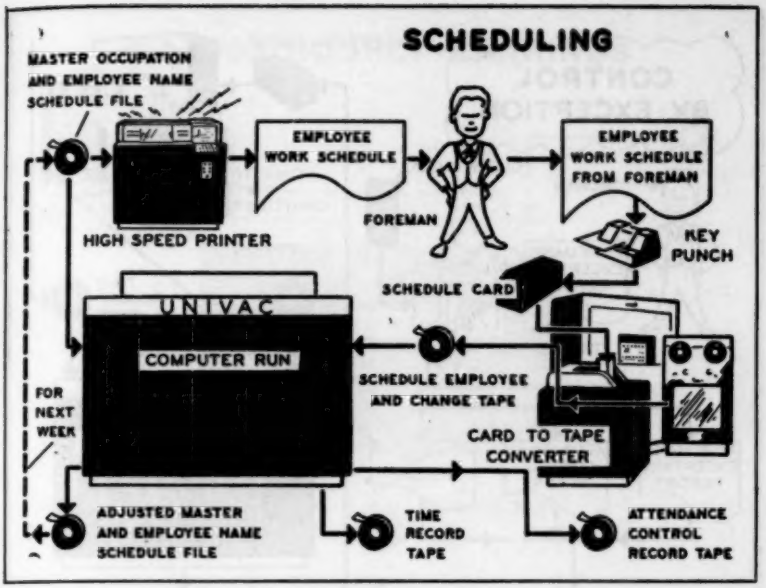

EXHIBIT 2

The gross-to-net payroll for our first works was converted to the computer two months later and, within a year from the time the programming began, this function was being processed on the computer for all five works.

Procedures: Work Scheduling to Net Pay

Our payroll is what is called a predetermined payroll, one which employs the principle of accounting by exception. An Employee Work Schedule (Exhibit 1) is prepared in advance, based on the normal weekly work pattern and showing the scheduled hours and occupation of each employee. This schedule is then adjusted during the week to show the way the men actually did work, and this becomes the basis for the payroll. The schedule is prepared on the high speed printer from a master schedule file.

The scheduling process is depicted in Exhibit 2. Starting with the master file tape, the incomplete work schedule is printed for the foreman. It is then completed by the foreman and forwarded to the data processing bureau where tabulating cards are keypunched to represent the changes from the previous week's schedule. Schedule change cards are recorded on magnetic tape by the card-to-tape converter. This tape is associated with the master

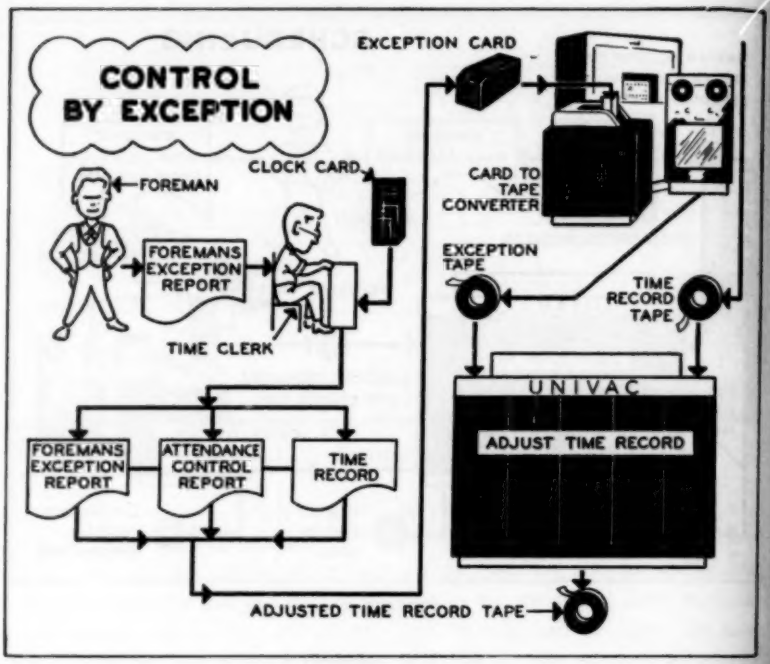

EXHIBIT 3

schedule tape in a computer run which provides the following:

1. Adjusted master file tape to be used the following week.
2. A tape which is used to prepare a time record.
3. A tape which is used to prepare an attendance control record.

One copy of the time record is sent to the foreman while another copy, together with the attendance control record, is sent to a time clerk in the clock station. The time record gives the foreman a complete record of how he scheduled his men. If each man worked as scheduled, it would actually represent the completed payroll for the week. Of course, this never happens and the foreman uses his copy of the Time Record to note deviations from the schedule and the reason for the deviations, thus converting it into an exception report.

How time utilization is reported upon through schedule exceptions is shown in Exhibit 3. The time clerk in the clock station receives the foreman's exception report and, since he also has a copy of the time record as well as the clock card, complete control can be exercised over attendance and payroll hours. He also has the

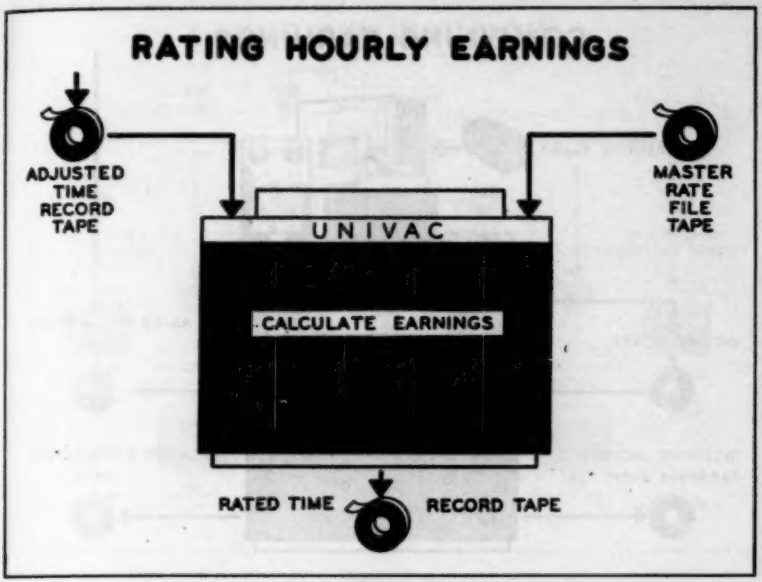

EXHIBIT 4

attendance control report, which is a listing of scheduled employees in strict employee number sequence. The purpose of this report is to facilitate attendance control since the time record is arranged by foreman's groups and crews, whereas clock cards are racked in straight numerical sequence. After checking the foreman's exception reports with his own controls, the clock station clerk forwards the exception reports to the data processing bureau. The exception reports are keypunched and the punched cards are recorded on tape by the card-to-tape converter. The exceptions tape is associated with the original time record tape to provide an adjusted time record tape representing actual payroll hours worked, by employee, by occupation.

Rated hourly earnings determination proceeds as in Exhibit 4. The adjusted time record tape is associated with a master rate file tape in a computer run where straight time, overtime and shift differential earnings are developed. The output of this run now contains both hours and earnings for all hourly rated employees. The earnings of incentive employees are still computed at the plant locations on punched card equipment. This will ultimately be a computer operation. However, at the present time, the incentive earnings are entered into the

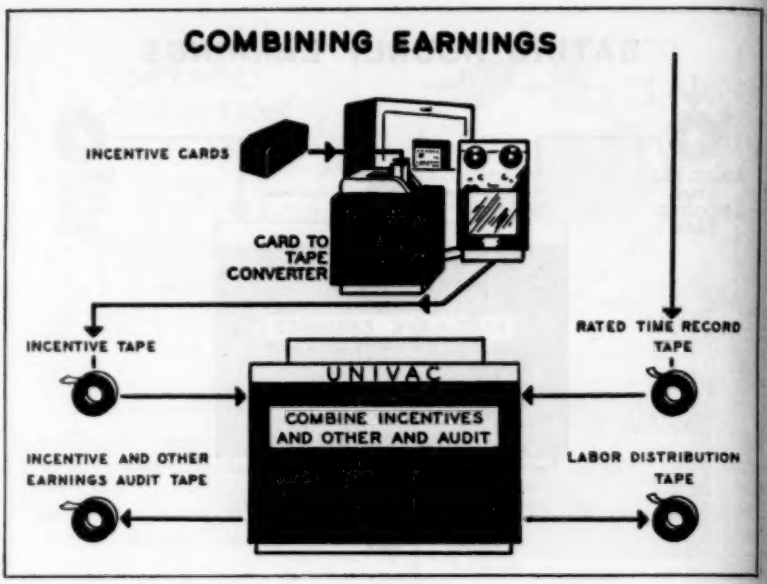

EXHIBIT 5

system through the medium of punched cards. The incentive earnings cards are converted to magnetic tape on the card-to-tape converter and are combined with hourly earnings in a computer operation. This procedure is the subject of Exhibit 5. The output of this run provides tapes for several purposes. One of the tapes prepared in the computer operation described is used for tabulation on the high speed printer of various labor distribution and statistical reports. Exhibit 6 is an example. The principal labor distribution report exhibits the cost and expense accounts for each organizational unit, that is, department, responsibility and operation. There are many other distribution reports covering payments for overtime, relief foremen, vacations, holidays, etc.

One set of tapes is associated with various master files to accomplish certain weekly audits as shown on Exhibit 7. Although our pay periods are bi-weekly, the operations discussed here are weekly, since we close and control payroll on a weekly basis. Weekly audits of hours and rates are made on the computer. These audits assure us that all hours to be paid for have been worked, are credited to the proper employee, and are associated with the correct occupation and job class. Each of these items has been verified on a daily basis and the weekly audits con-

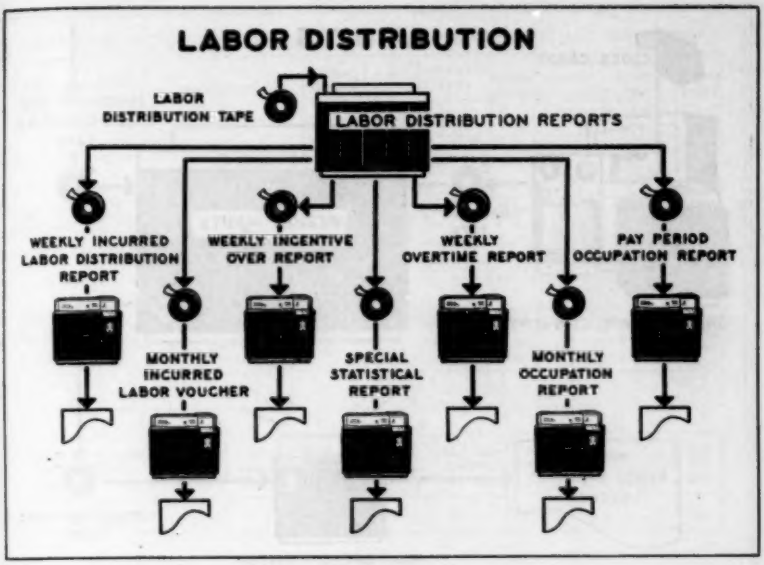

EXHIBIT 6

stitute a double check. The nature of the weekly audits may be illustrated by a discussion of one example. This is an audit of clock card hours versus payroll hours which is performed in conjunction with the preparation of the gross payroll summary. At the end of each week, the daily hours registered on the clock cards are added and the weekly hour total is gang-punched into each card. The clock cards are converted to tape and, during the computer run in which the gross payroll tape is prepared, clock card hours are zero-balanced by employee against payroll hours.

The final phase of payroll preparation is the gross-to-net procedure. One of the important elements of the gross-to-net payroll is the employee's master file. This contains:

1. Identifying information for each employee, such as name, Social Security Number, etc.
2. The payroll deduction data for taxes, insurance benefits, bonds, charities, union dues, etc.
3. The cumulative totals for gross earnings, hours, taxes deducted, etc.
4. Miscellaneous statistical data, such as birth date, sex, marital status, etc.

The employee master file is maintained on magnetic tape and used directly in that form. However, as the tapes cannot be read, it is occasionally necessary to print out these files for checking purposes. Exhibit 8 is a sample of such a print-out. Also, each time a change is made in any of the items of information for any employee or when a new employee is added, the

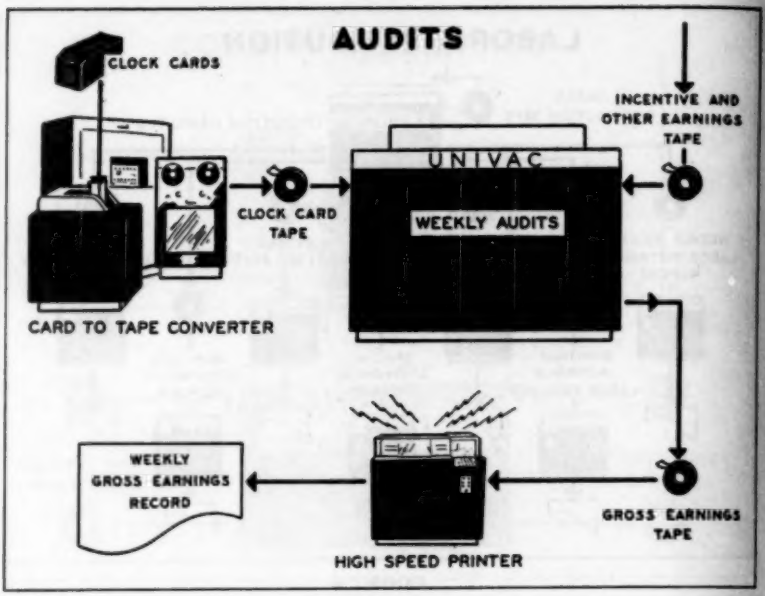

EXHIBIT 7

complete file for the employee is printed-out for checking purposes. This employee master file is brought up-to-date each pay period to reflect changes in deductions, new hires, terminations, etc. The procedure involved is reflected in Exhibit 9. Each of the plants forwards to the data processing bureau tabulating cards representing changes in the master file. The cards are converted to magnetic tape and the tape is processed on the computer with the master file to obtain a new running file tape. The new master tape or running file is associated on the computer with the gross earnings tape.

In this run all the calculations for the current pay, such as Federal Withholding tax, social security tax and the subtraction of all the deductions are accomplished. The output of this run provides a tape for the further processing of payroll as well as a tape to print out the net payroll control totals. These totals include not only the hours and earnings amounts being processed for net pay, but also the amounts for each type of deduction. Each works furnishes a deduction control by type of deduction, based on the increases and decreases since the previous pay, to which the computer controls are balanced. One final computer run, portrayed in Exhibit 10, provides tapes from which are printed the net payroll register, a denomination listing for

INDIVIDUAL EMPLOYEE PAYROLL FILE ACCESSIONS, CHANGES, AND SEPARATIONS

PAY TYPE	LOC.	CLOCK NUMBER	EMPLOYEE'S NAME	SOCIAL SECURITY NUMBER	SEX		EMPLOYEE'S BIRTH			MARITAL STATUS	CONTINUOUS VACATION SERV. DATE			WORKS STARTING DATE			WORKING STATUS
							MO.	DAY	YR.		MO.	DAY	YR.	MO.	DAY	YR.	
1	8	29026	P RENDULICH	19405587	1		11	15	90	2	11	23	06	11	23	06	00

TAX EXEMP	UNION CODE	LABOR REL. STA.	BONDS					INSURANCE BENEFITS PLAN							CLOCK NO. SUF.	WORK STATUS	ITEM CODE
			CODE	FIXED $ OR FIXED DED. AMT.	NO. PURCH.	DENOM. PURCH.	BALANCE	CODE	BASIC AMT.	BASIC DED. AMT.	OPTIONAL AMT.	OPTIONAL DED. AMT.	SURG. DED. AMT.	HOSP. DED. AMT.			
2	1	1	4	6 25	1	1	12 50	1	25 00	1 15	12 50	95	50	3 25		00	00

LOCAL HOSPITAL AND INSURANCE CLUB		CREDIT UNION			C.P.P.		CHARITY-1				CHARITY-2				WAGE TAX CODE	UNUSED VAC WKS.
CODE	DED. AMT.	CODE	FIXED DED. AMT.	PASS BOOK NUMBER	CODE	TO-DATE	PAYMENT	KIND	FIXED $ OR AMOUNT	PAYS LEFT	PAYMENT	KIND	FIXED $ OR AMT.	PAYS LEFT		
5	2 00	3	25 00	3402			1	A	5 00	2	5	D	50	17		1

WORKS GROSS TO-DATE	DIVISION GROSS TO-DATE	TOTAL HOURS TO-DATE	PAYS TO-DATE WORKED	WORKS FED. WITH'G TAX TO-DATE	WORKS F.I.C.A. TO-DATE	WKS. F.I.C.A. QUARTERLY BASE EARNS	EMPLOYEE'S CHANGE DATE			CURRENT WAGE TAX AMT. TO-DATE	LAST PAY WKD.
							MO.	DAY	YR.		
3894 56	2894 56	1512 0	19	343 18	57 89	918 16	01	06	55		19

EXHIBIT B

plants where payroll is disbursed in cash, the pay checks or pay envelopes, and the numerous deduction listings.

Problems Posed by Use of Computers in Accounting

The payroll procedure described here is, of course, only one of the applications for our computer. We have many other jobs for our computer, some planned, some being programmed and some already in operation. We do not know as yet how far into our management processes this conversion may ultimately extend. The use of electronic computers in business is still too new for any definition of their ultimate place in the business process. Undoubtedly, as experience is acquired, limits to their sphere of usefulness will appear and definite relations with other processing methods will be worked out. Undoubtedly, also new uses will arise that are as yet not imagined. For the present, perhaps the best we can do is to identify, and initiate thinking on, a few of the problems which have already made their appearance.

One of the questions raised by any computer installation is that of controls. It will be noted that, throughout the procedure, we have included substantially the same controls as would have been used if we were processing the payroll by other means. Even though the eletcronic computer, with its built-in safety checks and verifications, is far more accurate than any

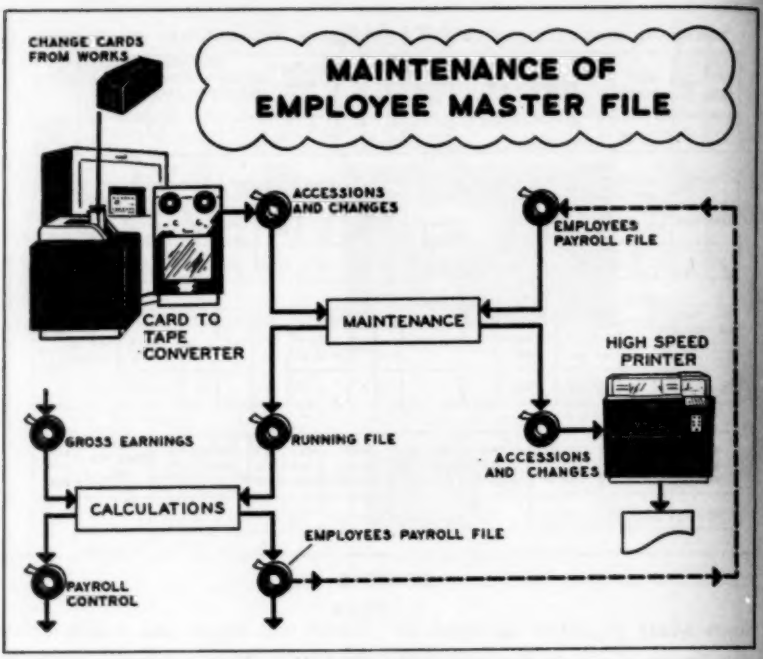

EXHIBIT 9

processing means we have had before, still, at this point in our experience, we feel there should be no let-down in controls until it has been fully demonstrated that they are unnecessary. We have, therefore, established check-points in our system, which involve the printing out of totals each time new data is introduced into the process and each time calculations or distributions are made. These checks serve to verify not only the accuracy of the machine operations but also the correctness of the input data. So far, these controls have proved important. Although we have not found a single error by the computer, we do find cases of incorrect input data. This points to the necessity of maintaining complete controls at least until the methods of preparing our input data achieve the accuracy level of the electronic computer.

This question of the type and degree of control over electronically processed data is no doubt of particular concern to auditors and controllers. Underlying this concern is, of course, the fact that electronic computers use an invisible medium, the magnetic pulse, and that extra operations of no direct value to the process are neces-

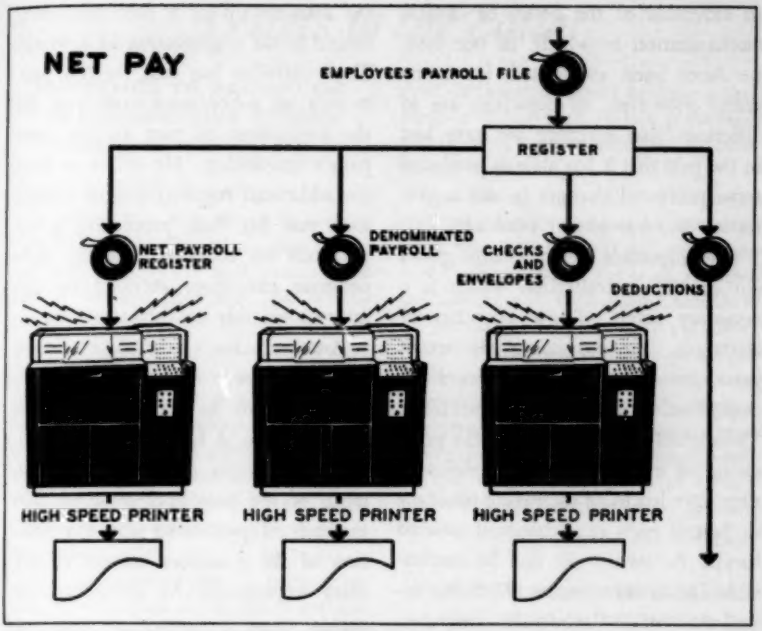

EXHIBIT 10

sary to print-out the data into visible form at any point short of the end of the process. This presents some interesting audit and control problems when viewed in terms of the ultimate prospect in integrated data processing, a situation in which its entire course, from raw data to final result, is in magnetic form. Although the auditor may grant that the computer will achieve a level of accuracy far superior to that of a human being and that the machine is entirely impartial and unfeeling in the way it goes about its job, he may still want to satisfy himself with visible evidence that the machine has functioned properly. This may require a large amount of extra work in converting data from magnetic to printed form. Our feeling is that, initially, all controls and audit methods will remain substantially the same as they were under older processes such as punched card systems. It is conceivable, however, that as experience with the computers accumulates and more confidence in their accuracy is acquired, the auditors, themselves, will rely on the computer to make their tests and samplings.

There are still other questions which use of computers raises. In one sense, our acquisition of the large-scale computer may be thought of as merely

an extension of the policy of clerical mechanization to which, in our case, we have been committed for many years. However, its capacities are so different from anything we have had in the past that it has already produced some profound changes in our organization and our way of thinking.

One important area of change grows out of the centralization which is a necessary result of the adoption of electronic data processing. In recent years, the trend has been toward decentralization of accounting functions. The difficulties of supervising the processing of ever-increasing quantities of data have led to an increasing tendency to permit each organizational unit to handle its own work and be responsible for its own results. With the installation of a large-scale computer, this trend is at once reversed. Due to the tremendous capacity, of this equipment it is usually necessary to concentrate all the work of one kind in one location in order to justify the cost and effort and secure the maximum results from the installation.

This centralization raises several problems. The most obvious one arises from the situation where the plant executive is given, for incorporation in his accounts, final figures concerning his own operation for which he must be responsible, but in the processing of which he has not had complete control. The answer to this problem appears to be in the realization and acceptance by top management of the relationship of a data processing center to the organization as a whole. The controller has had, in the past, to rely on subordinate executives for the correctness of part of the company's accounting. He will now have the additional responsibility of making sure that his data processing group performs its function correctly. Subordinate executives serviced by this group must rely on this assurance.

Another area of change, already noted, has been a shift in emphasis from the line to the staff functions in accounting. A high degree of mechanization greatly increases the importance of the personnel required. The methods of processing and the direction of the machines become of primary importance. As accounting becomes more a matter of planning control, the procedure specialist and the management or analytical accountant emerge as the human essentials in the mechanical accounting process. This shift in emphasis from the line accounting to the staff functions presents one of the problems of automatic accounting. Even in the short time since we undertook the use of these new techniques, we have begun to feel the change in our organization. Our general office procedure division, has greatly increased in size within the last two years. Correspondingly, executive attention has had to be directed much more toward the planning functions.

Letters to the Editor

IMPORTANCE TO MANAGEMENT OF DISTINGUISHING BETWEEN DIRECT AND INDRECT COSTS

Editor, N.A.C.A. Bulletin:

IT IS PRACTICALLY a universally accepted premise that management in general and managers in particular must possess some general technical knowledge and exercise certain acquired skills. The utilization of these skills and the degree of application within the company are reflected in the results achieved in terms of profits, competitive standing in the particular industry, and general corporate well being. This letter will deal with only those skills relating to the understanding, interpretation and use of data supplied to management by the cost accountant.

It is not suggested that the manager become an accountant or statistician but that he recognize, understand and foster the development of the principles and techniques used by cost specialists in preparing their reports.

For example, an operating manager should understand the full significance of why a distinction is made between the two broad classifications of direct and indirect costs. In practice, there are many variations and degrees of application of this distinction, ranging all the way from annual analytical standards to direct costing. Typical areas in which the classification is important include variable departmental budgets, company, branch or product break-even studies, marginal business, reports on income by product line, questions on investment in plant or equipment, relative production and distribution costs (between several operating plants), plant stand-by or shutdown costs, decisions to make or buy, and even pricing of inventory. The significance of management decisions in regards to these general topics is evident when we look at the range and scope of possible problems and questions in each case.

In summary, it appears that the key to good management decisions in matters relating to or based on cost data and reports of the cost department lies in an awareness and knowledge of the tools and methods of the accountant. This awareness and knowledge of methods and technique on the part of the operating manager assures two-way communications, eliminates misunderstandings while creating in the manager a point of view from which he is continually seeking a check on the soundness of his economics as applied in his everyday operating decisions.

WILLIAM F. GRADY

IS YOUR COMPANY LEADING OR FOLLOWING IN RESEARCH?

Editor, N.A.C.A. Bulletin:

DOES YOUR COMPANY want to lead the parade in its field or does it want to play follow the leader? This question must be answered when the development budget for the year is set up.

If the accountant is to help, he must keep in mind the whole picture of this endeavor. In order to control the development expenditures, we have placed the full responsibility of the research phase of development as well as customer engineering, techincal service to the factory, product improvement and process improvement under the responsibility of our development manager. Duties of our functional groups and indication of accounting treatment of the related costs is given in the paragraphs which follow.

Factory technical service works with the factory organization on production problems

on existing products. These duties include setting manufacturing specifications, quality control of raw materials, making material substitutions to effect savings or relieve shortages, and minor design of tools. The related costs are charged to regular manufacturing overhead.

Sales technical service works with the sales organization in connection with current products used by a customer or the extension of a brand line to a customer by adopting a current product. The costs are charged to selling expense and are accumulated by customer to measure development cost in relationship to sales by customers.

Product and process improvement covers work directed toward improvement of quality or reduction in costs of present production, usually involving major changes in the manufacturing specification. The costs of this group are charged to a special element of cost as burden. In this manner, we apply this cost on a part basis on total standard cost of a part. This eliminates the problem of cost allocation to production department or cost center, since the bulk of this work is identified to over-all problems on a part or commodity rather than to a production department. This also enables us to evaluate the development cost absorbed by a specific part we may be analyzing. The group handling new processes for existing products deals with developing of new processes for making an existing product either better or cheaper by design and construction of special equipment or experimental work to determine usefulness of equipment and quality of parts made by the new process. The cost of this work is also charged to our special element of cost as burden.

Basic research means planned investigation to obtain basic information without specific commercial objective. This does not include deliberate destruction of a part to see "what makes it tick". Cost is likewise charged to our special element of cost as burden. Research for new products and related processes covers work leading to the introduction of a new commodity or product, including design, experimental production, and other work in preparation for production on a commercial scale. The net cost, after deduction of saleable material produced during the experimental production, is charged to our special element of cost as burden.

Cost of general administration of development are prorated to the other functions described above. Typical of costs included as general administration are: development manager and secretaries, library expense, rent, and employee benefits.

The above explanation of our development expenditures and our costing practice do not answer our all important question "Can we afford the cost of development of a product?" It is the accounting division's responsibility to report the expenditures, but we must remember that all the figures that can be furnished are of little value until the technical man on the job takes action to control the costs. An annual development budget is basic. The engineers are assigned to the various projects for the year. This project schedule is costed by the accounting division and then, by joint effort of the development manager and budget manager, estimated development costs are compared with the sales by major commodity or product. The decisions are made on the information brought to light in this way. They involve much more by way of procedure than we can identify here. The object of this letter has been to give stature to an activity neglected by a company at its peril and to suggest avenues of control.

CLARENCE ORMSBY

Notes on Current Reading

Reporting Foreign Operations

Samuel R. Hepworth, Bureau of Business Research, School of Business Administration, University of Michigan, Ann Arbor, Michigan, 1956, 211 pp., $5.50.

Directed to practical accounting problems in the stating of accounts of foreign subsidiaries or other foreign operation, this study deals, in separate chapters with conversion of balance sheet and profit and loss accounts. Subsequent chapters take up exchange gain or loss, effects of controlled exchange rates, foreign currency devaluation, and whether or not to consolidate foreign accounts. The study is designated as Number 5 of Volume XII of Michigan Business Studies.

Corporate Finance

Elvin F. Donaldson, The Ronald Press Company, 15 East 26th Street, New York 10, N. Y. 1957, 876 pp., $7.50.

A textbook for business and economics students, this volume is issued at a time when the expansion of enterprises has thrown a new spotlight on the ways in which they are brought into being and growth sustained. The forms of business organizations, types of securities they may issue, and the process of promotion and financing are dealt with and a section of the book is devoted to "expansion and combination". Two sections enter the field of "administration" of income and working capital, respectively. Corporate terminations are also treated.

Company Investigations of Automatic Data Processing

Peter B. Laubach, Division of Research, Harvard Business School, Soldiers Field, Boston 63, Mass., paper bound, 1957, 258 pp., $3.00.

Central to this presentation is a 60-page study of how one company (anonymous) went through planning and installation stages of computer application. The style is narrative—and readable. The initial section of the study is entitled "Introduction and Description of Automatic Data-Processing Equipment." Short case illustrations (following the one mentioned above) are also included, as well as comments on and indications of practice. These form the concluding section.

Company Organization for Economic Forecasting

American Management Association, 1515 Broadway, New York 36, N. Y., 1957, Paper Bound.

Subtitled "Keeping Informed on the Business Outlook," this study is also identified as Research Report No. 28. It consists of two associated studies. One is a survey of 56 (responding number) company presidents as to their sources of economic information. The other is a report of uses of forecasts in twenty-one instances, plus a composite case treating ten additional companies more briefly.

Analysis for Production Management

Edward H. Bowman & Robert B. Fetter, Richard D. Irwin, Inc., Homewood, Illinois, 1957, 503 pp., $7.80.

The present work is in the area of application of statistics to production problems, with case material and appendices (one a glossary) following text. Teaching by example, say the authors, who are assistant professors in M. I. T. School of Industrial Management, is characteristic of "virtually all chapters." These cover introductory material, mathematical programming, statistical analyses (as for sampling) and economic analyses (as for lot-size determination).

SELECTED ARTICLES FROM ACCOUNTING PERIODICALS

ACCOUNTING RESEARCH, *January*, 1957 (Cambridge University Press, 32 East 57th St., New York, N. Y.)

Cost and Value of Management Information as Functions of Age. Robert H. Gregory and Thomas V. V. Atwater, Jr.

AUDITGRAM, *March*, 1957 (The National Association of Bank Auditors and Comptrollers, 38 South Dearborn St., Chicago 3, Illinois, single copy $.50)

A Current Review of Bank Operations. William H. Greenfield.
Bank Automation. C. M. Weaver.

CANADIAN CHARTERED ACCOUNTANT, *March*, 1957 (Chartered Accountants Bldg., 69 Bloor St., East, Toronto 5, Ontario, Canada, single copy $.50)

Integrated Data Processing—A Case History. A. A. Mackey.

THE CONTROLLER, *March*, 1957 (2 Park Avenue, New York 16, N.Y.)

An Approach to Selecting Economic Buying Quantities. Norman E. Lang.
Operations Research in Industry. Roger R. Crane.

COST AND MANAGEMENT, *January*, 1957 (31 Walnut St. South, Hamilton, Ontario, Canada, single copy $.50)

Measurement of Return on Capital Employed by Profit Centers. F. J. Muth.
Income Analysis for Multiple Industries. Lee L. Keener.
Integrated Data Processing—A Panel Discussion.

THE INTERNAL AUDITOR, *March*, 1957 (120 Wall Street, New York 5, N.Y., single copy $1.00)

A Valuable By-Product. Roy E. Tuttle.
Internal Auditing Objectives. Donald S. Grubbs.
Electronics and the Internal Auditor. Virgil F. Blank.
Auditing for Management. G. D. Bunce.

JOURNAL OF MACHINE ACCOUNTING, *March*, 1957 (6109 N. Karlov, Chicago 30, Illinois)

The Habit of Electronic Thinking. Glenn T. Bodman.

L. R. B. & M. JOURNAL, *Jan.-Mar.*, 1957 (Lybrand, Ross Bros. & Montgomery, 90 Broad St., New York 4, N.Y.)

Corporate Expansion Through Acquisition of an Existing Business. Joseph W. Bower.

THE NEW YORK CERTIFIED PUBLIC ACCOUNTANT, *February*, 1957 (677 Fifth Avenue, New York 22, N.Y., single copy $.50)

Some Factors to be Considered in Determining and Evaluating Fund-Raising Costs. Joseph A. Loewenstein.
The New Depreciation Regulations. William K. Carson.

THE NEW YORK CERTIFIED PUBLIC ACCOUNTANT, *March*, 1957

Financial Management in the Federal Government. Percy Rappaport.
Village Budget Preparation and Management. Joseph M. Cunningham.

RETAIL CONTROL, *February*, 1957 (100 West 31st Street, New York 1, N.Y., single copy $.75)

Merchandising Management Accounting . . . The Key to Profit. Roy H. Meyers, Robert I. Jones, Prof. Malcolm P. McNair.

SELECTED ARTICLES FROM BUSINESS PERIODICALS

AMERICAN BUSINESS, *March*, 1957 (4660 Ravenwood Avenue, Chicago 40, Illinois, single copy $.35)

Deferred Compensation—Bearing the Tax Bite. George Saum.
Delegating Doesn't Hurt. Donald A. Laird.
Controlling Office Supplies. Marilyn French.
We Centralize Our Payroll. Ross Loy.

BUSINESS BUDGETING, *January*, 1957 (National Society for Business Budgeting, P.O. Box 1, Covington, Kentucky)

The Why and How of Inventory Control. L. F. Neitzel.
Every Company Should Have a Budget Manual. Earle G. Mills.
Preliminary Considerations for the Operating Budget. H. C. Doofe.

HARVARD BUSINESS REVIEW, *Mar.-April*, 1957 (Soldiers Field Station, Boston 63, Massachusetts, single copy $1.50)

Guides to Internal Profit Measurement. Gordon Shillinglaw.
Steps in Long-Range Planning. Bruce Payne.
Make Your Staff Pay Its Way. Edward C. Schleh.
Financing Stock Purchases by Executives. V. Henry Rothschild.

MODERN OFFICE PROCEDURES, *February*, 1957 (Industrial Publishing Co., 812 Huron Road, Cleveland 15, Ohio)

Work Measurement in the Office.
Data Processing Reports.

THE OFFICE, *March*, 1957 (232 Madison Avenue, New York 16, N.Y., single copy $.35)

Employee Workshop Method Simplifies Training of Office Workers. C. C. Crawford.

OFFICE EXECUTIVE, *March*, 1957 (132 West Chelton Avenue, Philadelphia 44, Pennsylvania, single copy $.50)

A Practical Approach to Planning and Training. James H. Kohlerman.

SYSTEMS AND PROCEDURES QUARTERLY, *February*, 1957 (Box 281, Wall Street Station, New York, N. Y., single copy $1.00)

Purchase Versus Rental of Data Processing Equipment. Donald C. Niles.
The Computer in Commercial Data Processing. E. G. Benser.

For Your Information

ACCELERATED ODYSSEY OF AMERICAN BUSINESS

NOT QUITE A YEAR AGO, the topic of business operation in other countries was the center of attention at the 26th National Business Conference sponsored by the Harvard Business School Association. The proceedings, now issued in book form, (*Management Guide to Overseas Operations*, Dan H. Fenn Jr., McGraw-Hill Book Co., 330 West 42nd St., New York 36, N. Y., $4.50) gather and group the contributions of the participants to reproduce the substance of the addresses, panel papers and floor discussions. The chapters are, from this cause, multi-authored, with footnotes explaining the original nature of the contributions reflected in text. The result is an organized compilation of extended and informed observations on the theme of American business ventures abroad. The observations are those, mainly, of business leaders, with a sprinkling of government officials and diplomats.

Broad Picture Reflected

Far from an accounting book, the volume is not far from the interest of accountants, many of whose companies—or, at least, industries—are or are planning to sell or manufacture (or both) more extensively in other lands. This portion of American industrial enterprise can hardly be unlike domestic operations in its relationship to available pipe lines of information, especially channels of information which, like a carburetor, provide facts in a form distilled to give them operating effectiveness. This relationship is one of need for projections and reports, a need which accountants customarily claim to do much to fill and which would seem to be an especially pressing need in the pioneering conditions of venturing abroad. The very scarcity of guiding experience suggests that it needs prompt interpretation as it begins to accumulate. The fact, also, that such expansion extends lines of communications and control suggests that, where concerned at all, accountants will be doubly (or more) concerned, for the problems of gathering, digesting, issuing, and utilizing information are multiplied under these conditions.

These considerations, rather lightly, suggest the relevance of the present work to accountants. It is, however, as might be supposed, a background relevance. There are no procedures here, not even general business procedures. There are descriptions of problems of businesses which have expanded, problems such as securing investment, building plants abroad, hiring and dealing with labor, conforming to government regulations, maintaining markets, coordinating operations, etc. There are explanations, representative of business and government viewpoints (American and foreign) as to the purposes served by expansion of American business operation to lands under other sovereignties. There are both overtones of idealism and undercurrents of practicality evident in most of the contributions and expressions of dubiousness on many points are discernible in reports of floor discussions following addresses. In short, the many talks add up, in a sense, to a very general picture but it is comprehensive of geographical areas and business problems recognized, and so, it seems, rather suitable for carrying over the thinking of all whose familiar attention and concern is centered on one or more aspects of domestic business problems, to the same problems in the altered environment of foreign countries.

Little On Accounting

Something more particular will be said, in these few paragraphs, about the contents of *Management Guide to Overseas Operations*, but there is one more consideration of a general nature which it may be important, even helpful in a "left-handed" way, for accountants to notice. Several partners of public accounting firms and at least one company accounting official were on the program yet there was noticeable absence of mention of accountants and accounting processes as such. In dealing with investment and control problems, references to the use of accounting statements do occur but almost inadvertently as far as any central consciousness of the accounting function is concerned. Perhaps this is, to some extent, true of mention of other business functions but the absence of consciousness of accountants in matters with which accountants especially concern themselves may speak rather loudly to accounting ears.

Two possible significances suggest themselves. One is that accounting is an anonymous or behind-the-scenes function and best operates so. This thought has, surely, a reasonable ring to it. The other view is that accounting service is undeveloped in the area treated, or less well developed than it could be, and that accountants are challenged to greater usefulness by this seeming unawareness of their function. In either case the small awareness appears to be an evident, interesting and possibly significant fact.

Structure of the Book

Four main sectional groupings constitute the arrangement of the proceedings and consist of:

1. Overseas Business and the National Interest.
2. Management Problems and Case Histories.
3. Overseas Views of United States Business.
4. Foreign Operations and the Future of Capitalism.

The more concrete material (not necessarily the most information) appears in Section 2.

Orientation and Ideology

This section seems to be most pertinent to problems which the accountant would readily visualize as partly his own and the affiliation of the speakers suggest the wide industry representation of material offered. This is not to say that importance to the accountant is absent from other sections. In the first section, the national interest is related to overseas business expansion in a provocative way. In the third section, representatives of other nations (India, Brazil and Australia) supply receiving-end viewpoints of American industrial expansion abroad. The final section is ideological in character but so couched that it reminds us that we live and act daily and in our businesses upon ideological assumptions.